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CONTENTS

PAGE

1. Geologic Maps, Areal and Regional Geology (including Guidebooks) 1
2. Geomorphology 7
3. Structural Geology 13
4. Stratigraphy and Historical Geology 19
5. Paleontology 30
6. Geophysics 34
7. Geochemistry 43
8. Mineralogy and Crystallography 46
9. Igneous and Metamorphic Petrology 51
10. Sedimentary Petrology 54
11. Geohydrology 56
12. Mineral Deposits (including Geochemical Prospecting) 64
13. Fuels 70
14. Engineering Geology 75
15. Miscellaneous 77

The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

Akademiya Nauk SSSR, Izvestiya, Geologic Series, in English translation (American Geological Institute). Washington, D. C.
Alabama Academy of Science, Journal. Montevallo.
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Brigham Young University, Dept. of Geology, Brigham Young University Research Studies, Geology Series. Provo, Utah.
California, Division of Mines, Mineral Information Service. San Francisco.
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Carnegie Institution of Washington, Dept. of Terrestrial Magnetism, Annual Report of the Director, Washington, D. C.
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U. S. Atomic Energy Commission, [Publication].
U. S. Beach Erosion Board, Technical Memorandum. Washington, D. C.
U. S. Bureau of Mines, Information Circular; Report of Investigations. Washington, D. C.
U. S. Dept. of the Interior, Annual Report. Washington, D. C.
U. S. Geological Survey, Bulletin; Geologic Quadrangle Map; Mineral Investigations Map; Miscellaneous Investigations Map; Oil and Gas Investigations Map; Professional Paper; Water-Supply Paper. Washington, D. C.
West Virginia Academy of Science, Proceedings. Morgantown.

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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-3953, 3-3954, 3-3956; Geomorphology 3-3986; Structural Geology 3-4009; Stratigraphy 3-4044; Igneous and Metamorphic Petrology 3-4190; Geohydrology 3-4207, 3-4223; Mineral Deposits 3-4247.

3-3943. Snyder, George L. GEOLOGIC MAP OF THE NORWICH QUADRANGLE, CONNECTICUT: U.S. Geol. Survey, Geol. Quad. Map GQ-144, scale 1:24,000, lat. 41°30'-41°37'30"N., long. 72°-72°07'30"W., 1961.

Metasedimentary and metaigneous(?) rocks of middle or upper Paleozoic (?) age underlie the entire Norwich quadrangle. Four zones of progressive regional metamorphism from kyanite zone (almadine amphibolite facies) to hypersthene or cordierite zone (granulite facies) are mapped. Following the thermal peak, dynamic metamorphism was concentrated along a major fault zone. Subsequently, alteration resulted in the hydration of much high-grade schist in the area. The petrography is briefly described and structural features are explained.--U. S. Geol. Survey.

3-3944. Maughan, Edwin K. GEOLOGY OF THE VAUGHN QUADRANGLE, MONTANA: U.S. Geol. Survey, Geol. Quad. Map GQ-135, scale 1:62,500, lat. 47°30'-47°45'N., long. 111°30'-111°45'W., 1961.

The Vaughn quadrangle lies athwart the Sweetgrass arch about 10 mi. W. of Great Falls. The Marias River shale and the Blackleaf formation of Cretaceous age are mapped with 4 members each. Surficial deposits consist chiefly of Pleistocene terrace gravel and glacial lake sediments. The map is accompanied by a columnar section, cross sections, and brief text summarizing the bedrock and surficial units, their geologic history, economic and engineering importance, and the structure of the area.--U.S. Geol. Survey.

3-3945. Colton, Roger B., and others. GLACIAL MAP OF MONTANA EAST OF THE ROCKY MOUNTAINS: U.S. Geol. Survey, Misc. Inv. Map I-327, scale 1:500,000, lat. 47°-49°N., long. 104°-113°W., 1961.

3-3946. Wrucke, Chester T., and C.S. Bromfield. RECONNAISSANCE GEOLOGIC MAP OF PART OF THE SOUTHERN PELONCILLO MOUNTAINS, HIDALGO COUNTY, NEW MEXICO: U.S. Geol. Survey, Mineral Inv. Map MF-160, scale 1:62,500, lat. 31°30'-31°45'N., long. 108°50'-109°W., 1961.

3-3947. Disbrow, Alan E. GEOLOGY OF THE BOULTER PEAK QUADRANGLE, UTAH: U.S. Geol. Survey, Geol. Quad. Map GQ-141, scale 1:24,000, lat. 40°-40°07'30"N., long. 112°07'30"-112°15'W., 1961.

The Boulder Peak quadrangle, about 50 mi. SSW. of Salt Lake City, covers the western part of the N. Tintic mining district. Consolidated sedimentary and volcanic rocks range in age from Early Cambrian to Tertiary. Unconsolidated deposits of Pleistocene and Recent age are also present. Ag, Pb, and Zn have been mined in the area; Cu minerals are known but have not been mined.--U. S. Geol. Survey.

3-3948. Grolier, Maurice J., and Bruce L. Foxworthy. GEOLOGY OF THE MOSES LAKE NORTH QUADRANGLE, WASHINGTON: U.S. Geol. Survey, Misc. Inv. Map I-330, scale 1:24,000, lat. 47°07'30"-47°15'N., long. 119°15'-119°22'30"W., 1961.

Quadrangle covers about 50 sq. mi. in central Washington, including Larson Air Force Base. The bedrock in the region is Yakima basalt which is overlain successively by lacustrine deposits and glaciofluvial gravel. Distribution of the various rock units is shown on the map; thickness of the sedimentary deposits and attitude of the basalt are shown in 2 cross sections. Fossil ostracodes from the lacustrine deposits are reported for the first time.--U. S. Geol. Survey.

3-3949. Richardson, Everett E. GEOLOGIC AND STRUCTURE MAP OF THE NORTH FORK OIL FIELD, KAYCEE DOME, AND VICINITY, JOHNSON COUNTY, WYOMING: U.S. Geol. Survey, Oil & Gas Inv. Map OM-206, scale 1:24,000, lat. 43°40'-43°50'N., long. 106°35'-106°52'W., 1961.

3-3950. Harrison, Richard Edes. THE FLOOR OF THE WORLD OCEAN: Assoc. Am. Geographers, Annals, Map Supp. no. 2 (pub. in: Annals, v. 51, no. 3, Sept. 1961; also available separately), scale 1:50,000,000, Association of American Geographers, 1785 Massachusetts Ave., N.W., Washington 6, D.C., 1961.

A modified and completely re-drawn version of the map appearing in Fortune, Nov. 1959, under the title; "The Newly Discovered World Beneath the Waves." The reconstruction was necessitated by the accidental incineration of the originals. The chief modifications in the present version are: 1) the ocean currents shown on the 4-color Fortune map, are omitted; 2) the Arctic basin is here shown complete; 3) the projection was further modified in the upper center in order to reduce the distortion in the NW. Pacific area. This map is a visual interpretation of the latest available bathymetric data. In view of our incomplete knowledge, the drawing incorporates a number of surmises - especially in the adequately surveyed portions of the Indian and Pacific Oceans.--Auth.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geohydrology 3-4225; Mineral Deposits 3-4251.

3-3951. Raasch, Gilbert O., ed. GEOLOGY OF THE ARCTIC. Proceedings of the First International Symposium on Arctic Geology, held in Calgary, Alberta, January 11-13, 1960, under the auspices of the Alberta Society of Petroleum Geologists: 2 v., and 32 figs. and tables under separate cover, Toronto, University of Toronto Press, 1961, refs.

The papers in these symposium volumes represent contributions from representatives of Canada, the United States, the United Kingdom, the Scandinavian countries and the U.S.S.R. Papers are listed below in the order in which they appear in the volumes. Full papers with author abstracts (except nongeologic papers on logistics, climate, etc.) are abstracted separately in the appropriate subject sections of this issue of GeoScience Abstracts. Unabstracted papers are marked with an asterisk. Titles represented by abstracts only are so noted.

Section One: Regional Geology

SOVIET ARCTIC

Main Features of the Tectonic Development of the Central Soviet Arctic. By I. P. Atlasov and V. N. Sokolov.

The Precambrian of the Soviet Arctic. By M. I. Rabkin and M. G. Ravich.

The Palaeozoic of the Soviet Arctic. By F. G. Markov and B. V. Tkachenko.

Mesozoic and Cenozoic of the Soviet Arctic. By V.N. Sachs and S. A. Strelkov.

SPITSBERGEN

An Outline Structural History of Spitsbergen. By W. B. Harland.

Radiocarbon Dating of Raised Beaches in Nordaustlandet, Spitsbergen. By Weston Blake, Jr.

GREENLAND

*A Summary of the Geology of North and East Greenland. Editorial Foreword.

Precambrian and Early Palaeozoic Structural Elements and Sedimentation: North and East Greenland. By Lauge Koch.

The Carolinides: An Orogenic Belt of Late Precambrian Age in Northeast Greenland. By John Haller.

The Lower Palaeozoic Geology of Greenland. By J. W. Cowie.

Account of Caledonian Orogeny in Greenland. By John Haller.

Devonian Deposits of Central East Greenland. By H. Butler.

Devonian Vertebrates. By Erik Jarvik.

Continental Carboniferous and Lower Permian in Central East Greenland. By H. Butler.

The Permian of Greenland. By Wolf Maync.

Permian Invertebrate Faunas of Central East Greenland. By Carl O. Dunbar.

Permian Vertebrates. By Erik Stensiö.

Triassic of East Greenland. By Rudolf Trümpy.

*On the Eotriassic Fish Faunas of Central East Greenland. By Eigil Nielsen.

The Jurassic System in East Greenland. By J. H. Callomon.

The Rhaeto-Liassic Flora of Scoresby Sound, Central East Greenland. By T. M. Harris.

Cretaceous of East Greenland. By D. T. Donovan.

Tertiary of Greenland. By Eduard Wenk.

Palaeomagnetic Studies of Some Greenland Rocks. By D. E. T. Bidgood and W. B. Harland.

*Journeys and Expeditions to Greenland in the Years 1913-59: A Summary. By Lauge Koch.

Late Precambrian to Cambrian Stratigraphy in East Greenland. By H. R. Katz.

On the Chronology of the Precambrian of Western Greenland. By Asger Berthelsen.

CANADA

Structural History of the Canadian Arctic Archipelago since Precambrian Time. By R. Thorsteinsson and E. T. Tozer.

Precambrian Geology of Arctic Canada: A Summary Account. By R. G. Blackadar and J. A. Fraser.

*Lower Palaeozoic Stratigraphy of the Canadian Arctic Archipelago [abstract only]. By R. Thorsteinsson.

Summary Account of Mesozoic and Tertiary Stratigraphy, Canadian Arctic Archipelago. By E. T. Tozer.

Pleistocene Geology of Arctic Canada. By B. G. Craig and J. G. Fyles.

Relations of the Parry Islands Fold Belt and the Cornwallis Folds, Eastern Bathurst Island, Canadian Archipelago. By Andrew H. McNair.

Geological Interpretation of Aeromagnetic Profiles from the Canadian Arctic Archipelago. By A. F. Gregory and others.

Gypsum Tectonics on Axel Heiberg Island, Northwest Territories, Canada. By E. H. Kranck.

Tectonic Framework of Northern Canada. By L. J. Martin.

Caledonian or Acadian Granites of the Northern Yukon Territory. By H. Baadsgaard and others.

The Silurian Aulacopleura Socialis in the Yukon Territory. By G. O. Raasch and others.

Devonian Stratigraphy, Central Mackenzie River Region, Northwest Territories, Canada. By H. G. Bassett.

*Devonian Stratigraphy – Norman Wells Region [abstract only]. By Taras P. Storey.

Devonian Rugose Corals of the Lower Mackenzie Valley, Northwest Territories. By Alfred C. Lenz.

Micropalaeontological (Foraminifera) Zonation of the Sans Sault Group, Lower Mackenzie River Area. By Peter C. McGill and D. M. Loranger.

Eastern Slope, Richardson Mountains: Cretaceous and Tertiary Structural History and Regional Significance. By J. A. Jeletzky.

Evaporite Piercement Structures in the Northern Richardson Mountains. By P. E. Kent and W. A. C. Russell.

ALASKA

*Progress Report: A Study of Tectonics of Alaska [abstract only]. By George Gryc.

*Correlation of Palaeozoic Rocks in Alaska [abstract only]. By J. Thomas Dutro, Jr.

*Newly Recovered Upper Tertiary Non-Marine Sediments in Alaska and Northwestern Canada [abstract only]. By William S. Benninghoff and others.

*Preliminary Report on Upper Cenozoic Carbonaceous Deposits in the Johnson River Area, Alaska Range [abstract only]. By William S. Benninghoff and G. William Holmes.

Ostracoda from the Pleistocene Gubik Formation, Arctic Coastal Plain, Alaska. By Frederick M. Swain.

ARCTIC OCEAN BASIN

History of Geologic Thought on the Origin of the Arctic Basin. By A. J. Eardley.

The Mid-Oceanic Ridge and its Extension through the Arctic Basin. By Bruce C. Heezen and Maurice Ewing.

*Former Mountain Connections in the Arctic [abstract only]. By J. Tuzo Wilson.

*Arctic Basin Geomorphology [abstract only]. By Robert S. Dietz and George Shumway.

Seismic Studies of the Arctic Ocean Floor. By Kenneth Hunkins.

Dredged Gravels from the Central Arctic Ocean. By Walter Schwarzacher and Kenneth Hunkins.

Bathymetry of the Beaufort Sea. By A. J. Carsola and others.

Preliminary Results of Investigations on Arctic Drift Station Charlie. By William J. Cromie.

Geophysical Studies on IGY Drifting Station Bravo, T-3, 1958 to 1959. By Donald Plouff and others.

*Marine Geological Observations from the Barents Sea [abstract only]. By Heikki Ignatius.

Marine Geology and Bathymetry of the Chukchi Shelf off the Ogotoruk Creek Area, Northwest Alaska. By D. W. Scholl and C. L. Sainsbury.

Section Two: Glaciology, Permafrost, Climatology, Geomorphology, etc.

Danish Glaciological Investigations in Greenland. By Børge Fristrup.

Late Pleistocene Glaciation in Northeast Greenland. By Daniel B. Krinsley.

Surface Features of the Ice-Cap Margin, Northwestern Greenland. By Laurence H. Nobles.

Periglacial Phenomena in Canada. By Frank A. Cook.

Comparison of Gravitational and Seismic Depth Determinations on the Gilman Glacier and Adjoining Ice-Cap in Northern Ellesmere Island. By J. R. Weber.

Some Glaciological Studies in the Lake Hazen Region of Northern Ellesmere Island. By G. Hattersley-Smith.

Induction and Galvanic Resistivity Studies on the Athabasca Glacier, Alberta, Canada. By G. V. Keller and F. C. Frischknecht.

A Distribution Study of Abandoned Cirques in the Alaska-Canada Boundary Range. By Maynard M. Miller.

Glacial Geology of the Mount Chamberlin Area, Brooks Range, Alaska. By G. William Holmes and Charles R. Lewis.

Glacial Marine Sedimentation. By S. Warren Carey and Naseeruddin Ahmad.

*Pleistocene Physical and Biologic Environments of Pacific Southcentral and Southwestern Alaska [abstract only]. By Thor N. V. Karlstrom.

Sequential Development of Surface Morphology on Fletcher's Ice Island, T-3. By David D. Smith.

*The Major Factors of Arctic Climate. By H. P. Wilson.

Pleistocene Climate Changes. By Maurice Ewing and William L. Donn.

*A Survey of Temperatures in the Canadian Arctic. By M. K. Thomas.

Permafrost Investigations in Canada. By R. F. Legget and others.

Seismic Refraction Soundings in Permafrost near Thule, Greenland. By Hans Roethlisberger.

Surface Features of Permafrost in Arid Areas. By William E. Davies.

*A System for the Refrigeration of Drilling Fluids for Rotary Drilling and Coring in Frozen Earth Materials [abstract only]. By G. Robert Lange.

An Investigation into Methods of Accelerating the Melting of Ice and Snow by Artificial Dusting. By K. C. Arnold.

Ground-Water Hydrology in Alaska. By D. J. Cederstrom.

*Mechanical Aspects of the Contraction Theory of Ice-Wedge Polygons [abstract only]. By Arthur H. Lachenbruch.

Hydrodynamic Analysis of Circulation and Orientation of Lakes in Northern Alaska. By R. W. Rex.

Dating Rock Surfaces by Lichen Growth and its Application to Glaciology and Physiography (Lichenometry]. By Roland E. Beschel.

Mud Volcanoes in the Copper River Basin, Alaska. By Donald R. Nichols and Lynn A. Yehle.

*Essay on Palaeoclimatology from Palaeozoic to Quaternary Eras in Northern Ellesmere Island [abstract only]. By Michel Brochu.

*The Origin of Cold High Salinity Water in Foxe Basin and Foxe Channel [abstract only]. By N. J. Campbell.

*Oceanic Observations in the Canadian Arctic and the Adjacent Arctic Ocean [abstract only]. By A. E. Collin;

*Thrust Fracture Pattern in Young Sea Ice [abstract only]. By Moira Dunbar.

*The Ground Ice in the Deer Bay Area, Ellef Ringnes Island, Northwest Territories [abstract only]. By Denis St-Onge.

Section Three: Logistics and Exploration

Field Methods and Logistics: Arctic Canada. By R. G. Blackadar.

Modern Methods of Exploration in the Canadian Arctic Islands with Special Respect to Logistic Problems. By T. A. Harwood.

*Forecasting Sea Ice Conditions. By W. E. Markham.

*Freeze-Up and Break-Up of the Lower Mackenzie River, Northwest Territories. By J. Ross Mackay.

*Transportation in the Canadian North. By R. A. Hemstock.

Regional Geology and Petroleum Prospects: Lower Mackenzie Basin and Arctic Coastal Area, Northwest Territories. By J. C. Sproule.

Operational Report on a Gravity Meter Survey Conducted on the Arctic Coastal Plain. By L. N. Ingall and R. J. Copeland.

Marine Seismograph and Sparker Survey in the Mackenzie River, Northwest Territories. By Jimmie G. Meador.

Geochemical Prospecting for Base Metals in Schuchert Dal, Northeast Greenland. By Alan Reece and A. L. Mather.

Activities of Norsk Polarinstitutt (Norwegian Polar Institute) in Svalbard. By Thore S. Winsnes.

*Geological Investigation of Greenland: Past and Present. By K. Ellitsgaard-Rasmussen.

Jacobsen-McGill University Expedition Axel Heiberg Island 1959-61. By George Jacobsen.

The Arctic Institute of North America. By A. T. Belcher.

3-3952. Koch, Lauge. PRECAMBRIAN AND EARLY PALAEOZOIC STRUCTURAL ELEMENTS AND SEDIMENTATION, NORTH AND EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic. . . : v. 1, p. 148-154, map, Toronto, University of Toronto Press, 1961)

Considering Greenland as a part of the Canadian shield, we find in N. and E. Greenland 3 geosynclines each with its own geological history.

1) NW. geosyncline (eastern part of Innuitian). Archean shield exposed in Thule district and Inglefield land. Sedimentation: psammites with basalt (upper Thulean, 3,000 m.). Lower, middle, and upper Canadian, Mohawkian, Richmond (1,500 m.), Llandovery, Wenlock, Ludlow (3,000+ m.). In Silurian disconformities and sedimentation from the rising mountain range (530 km.) along the N. coast. Caledonian folding in W. mild, in E. stronger. No Devonian sediments N. of 76°N. in Greenland.

2) NE. geosyncline (Archean shield exposed Victoria fjord and Dronning Louise land). a) Sedimentation: semi-pelites (3,000+ m.) and coastal plain psammites (3,000+ m.), basalt = lower and upper Thulean. b) Folding + granites + faulting + basalt = Carolinidian mountain chain (800 km.) at the NE. corner of Canadian Shield, may or may not continue on the N. coast of Ellesmere Island. c) Denudation: to the E. a basin; semipelites (4,500 m.); to the W. a clastic wedge 1,700 m. (= Hagen fjord group) + Lower Cambrian, Champlainian, Wenlock, and Ludlow. d) Strong Caledonian folding with granites and great overthrust to the W. e) Denudation to the E.; Dinanthian + Namurian(?) (continental), middle Carboniferous, Lower Permian, Triassic, Cenozoic(?) (marine). f) Mild Tertiary folding faulting + basalt (400 km.).

3) Central E. geosyncline (Archean shield exposed in Dronning Louise land and SW. Scoresby sound). a) Sedimentation: tillite, semi-pelites, and pelites with 2 limestone horizons and psammites, pelites,

limestone, and dolostone = lower and upper Eleonore bay group and Tillite group (12,000+ m.), Lower Cambrian, Canadian, and Champlainian (3,000+ m.). b) Strong Caledonian folding first in Silurian with granites, later folding with granites in Middle and Upper Devonian, and molasse basins 13,000 m. with Givetian, Frasnian, Famennian, Strunian, Tournaisian, Namurian, Westphalian, Stephanian, and Lower Permian; last folding in Tournaisian, but faulting to the end of Middle Permian. c) Calm period with Upper Permian marine transgression in Mesozoic basins and coastal plains up to the end of Senonian. d) In Tertiary widespread plateau basalt, local acid plutons. Strong faulting, local folding, local Eocene, Oligocene, and Miocene marine sediments.--Auth.

3-3953. Sainsbury, Cleo L. GEOLOGY OF PART OF THE CRAIG C-2 QUADRANGLE AND ADJOINING AREAS, PRINCE OF WALES ISLAND, SOUTHEASTERN ALASKA: U.S. Geol. Survey, Bull. 1058-H, p. 299-362, map, 7 pls. incl. col. geol. map (in pocket), scale 1:63,360, 1961, 14 refs.

The area mapped is on the E. coast of Prince of Wales Island, southeastern Alaska, about 35 mi. NW. of the town of Ketchikan. Deposits of magnetite and Cu in the mapped area and on Kasaan Peninsula, which adjoins it on the SE. have been mined for Cu and have produced more than 600,000 tones of ore valued at more than $6 million.

The bedded rocks of the area are composed of a great thickness of volcanic graywacke, tuff, conglomeratic volcanic graywacke, argillite, andesite, limestone, and conglomerate ranging in age from Middle Ordovician to Early Silurian(?). The age assignments of the bedded rocks, which previously were assigned to the Middle Devonian, are based upon 6 collections of graptolites. The thickness of the Middle Ordovician and Lower Silurian(?) rocks is not apparent, but it must be at least several thousand feet and may be as much as 17,000 ft. The structure of the bedded rocks undoubtedly is more complex than can be determined in the field.

An island in Kasaan Bay in the southern part of the mapped area is composed of limestone of Middle Devonian age. This limestone is in an anomalous position with respect to the older rocks and is thought to have been faulted into its present position sometime in the Tertiary, probably by thrust faulting on a major scale followed by block faulting.

Small deposits of Tertiary conglomerate of local derivation, some of which have the form of old deltas, lie unconformably on the older rocks. These Tertiary rocks are restricted to the lowland areas.

Surficial deposits of till, outwash gravel, and alluvium are widespread. Glacial features show that at one stage in the cycle of glaciation, ice flowed eastward from a center or centers W. of the quadrangle. This is interpreted as evidence of valley glaciation that preceded and followed an ice sheet that completely buried mountains as much as 2,800 ft. in altitude. Postglacial uplift amounts to at least 50 ft. and may be more than 200 ft.

The older rocks are intruded by many stocklike bodies of probable middle Cretaceous age ranging in composition from granite to olivine-bearing pyroxenite, and by innumerable dikes. The age of 1 stock was determined on the basis of radiogenic Pb to be 100 million years, or middle Cretaceous.

The igneous rocks of intermediate composition in places contain large amounts of alkali feldspar, and many dikes are converted to albite-rich rocks. The identification of anorthoclase phenocrysts in some of the sodic dikes raises the question as to which of the sodic rocks are primary and which are albitized.

Three distinct periods of ore deposition are recognized, each with characteristic ore and gangue minerals. The oldest and most important is related to the intrusive activity of probable late Early to Late Cretaceous age; the second, of lesser importance, postdated the intrusion of diabase dikes, probably in the early Tertiary; and the youngest and least important either followed or was contemporaneous with the intrusion of pitchstone dikes that cut the Tertiary conglomerate.

The association of magnetite ore with older bedded rocks rich in magnetite and with pyroxene that tends to be rich in Fe suggests that the bedded rocks may be the source of at least part of the magnetite in the magnetite-chalcopyrite ores.--Auth.

3-3954. Coats, Robert R., and others. GEOLOGIC RECONNAISSANCE OF KISKA ISLAND, ALEUTIAN ISLANDS, ALASKA: U.S. Geol. Survey, Bull. 1028-R, p. 563-581, 5 illus., 2 maps incl. col. geol. (in pocket), scale 1:63,360, table, 1961, 19 refs.

Kiska Island, in the Rat Island group of the Aleutian Islands, is composed of 2 major geologic elements. The S. half of the island is part of a submarine ridge, and the N. half is a volcano. Kiska Volcano is a young composite andesitic volcano. It is underlain and flanked on the S. by the Kiska Harbor formation, which represents remnants of an old older composite volcano. The Kiska Harbor formation is unconformable with the Vega Bay formation to the S. The Vega Bay formation is a mass of deformed submarine volcanic rocks.

Both Kiska Volcano and the Kiska Harbor formation are composed of interbedded andesitic to basaltic pyroclastic rocks, lava flows, and sedimentary rocks formed of volcanic debris. The rocks of the Vega Bay formation are older and more deformed than the other rocks of the island; they are composed of moderately well indurated pyroclastic rocks and substantial amounts of dark submarine basalt flows and minor amounts of sandstone and conglomerate formed of volcanic debris.

The island was sculptured first by marine and fluvial erosion, and the southern part of the island was later modified by glaciation. The northern part of the island shows no signs of glaciation. The island is thinly veneered by volcanic ash derived largely from volcanoes on nearby islands.--Auth.

3-3955. Rocky Mountain Association of Geologists. SYMPOSIUM ON LOWER AND MIDDLE PALEOZOIC ROCKS OF COLORADO. Robert R. Berg, and John W. Rold, Editors: 236 p., geol. map (in pocket, 2 sheets) scale approx. 1 in. to 9 mi., 98 figs. incl. maps, secs., 9 pls. (1 in pocket), 4 tables, Denver, Colorado, 1961, refs.

During the past 2 years oil and gas discoveries in southwestern Colorado and eastern Utah, as well as previous discoveries in western Kansas, have focused the attention of the many commercial geologists on the older Paleozoic horizons. This twelfth field conference of the Rocky Mountain Association of Geologists took place in S.-central Colorado on Sept. 7-8, 1961. Contents of the symposium are listed below.

REGIONAL GEOLOGY

Schematic Cross Section of Lower and Middle Paleozoic Rocks, Southeast Utah to Southwest Kansas, by J. W. Rold.

Cambrian and Lower Ordovician Stratigraphy of Central Colorado, by D. N. Stevens.
Middle and Upper Ordovician Rocks, Central Colorado, by W. C. Sweet.
Devonian and Mississippian Stratigraphy of Central and Northwestern Colorado, by D. N. Bloom.
Correlation of Pre-Pennsylvanian Rocks, South Flank of Sand Wash Basin, Northwest Colorado, by H. R. Ritzma.
Cambrian, Ordovician and Devonian Systems, Eastern Colorado Subsurface, by J. C. MacLachlan.
Mississippian Rocks of Eastern Colorado, by S. C. Tapp.
Cambrian, Devonian and Mississippian Rocks and Pre-Pennsylvanian Structure of Southwest Colorado and Adjoining Portions of Utah, Arizona, and New Mexico, by J. M. Parker.
Devonian and Mississippian Rocks of the Four Corners Region, by D. R. Turnbow.
Mississippian-Pennsylvanian Boundary in Southwestern Colorado, by W. M. Merrill and R. M. Winar.
Early and Middle Paleozoic Index Fossils of Colorado, by John Chronic.
Structure Contour Map of Colorado, by G. G. Anderman.

LOCAL GEOLOGY

Structure and Lower and Middle Paleozoic Stratigraphy of the Wellsville Area, Colorado, by J. W. Rold.
Pre-Pennsylvanian Stratigraphy of the Monarch District, Chaffee County, Colorado, by C. S. Robinson.
Outline of the Geology of the Cement Creek Area, Gunnison County, Colorado, by A. C. McFarlan.
Pre-Pennsylvanian Rocks of the Canon City Area, by E. A. Frederickson.
Early Paleozoic Outlier in Southeastern Wyoming, by John Chronic.

ECONOMIC GEOLOGY

The Oil and Gas Potential of the Lower and Middle Paleozoic Rocks of Southeast Colorado, by J. W. Rold.
The Pleasant Prairie Field, Kansas, by R. E. Roby.
Oil and Gas Possibilities of Pre-Pennsylvanian Rocks in Northeastern Colorado, by E. J. Ackman and H. P. McLish.
McIntyre Canyon and Lisbon Oil and Gas Fields, San Miguel County, Colorado, and San Juan County, Utah, by J. M. Parker.
Detailed Lithologic Zonation of the Mississippian at Northwest Lisbon Field, Utah, by J. G. Mitchell.
Metallic Deposits in Pre-Pennsylvanian Rocks of Southwest Colorado, by M. A. Klugman.
Non-Metallic Minerals from Rocks of Lower and Middle Paleozoic Age, by Lawrence Ogden.

REFERENCES

Correlation Chart, Lower and Middle Paleozoic Rocks, Colorado.
Catalog of the Pre-Pennsylvanian Stratigraphic Names of Colorado, by R. H. DeVoto.
Selected Bibliography for Early and Middle Paleozoic Geology of Colorado, by John Chronic.

FIELD CONFERENCE

The High Country, by W. L. Dockery.
Narrow Gauge Ghosts of the Field Trip Area, by Jack Rathbone.
Road Logs, by J. L. Moyer.

3-3956. Caldwell, Dabney W. THE GEOLOGY OF BAXTER STATE PARK AND MT. KATAHDIN: Maine Geol. Survey, State Park Geol. Ser. no. 2, 54 p., 19 illus., 2 col. geol. maps and col. sec. on fold. pl., 4 diags., table, 1960.

This report, written in semipopular style, describes the geology of the State Park area and vicinity. Three principal types of rocks form the bedrock of Baxter State Park - granite, volcanic, and sedimentary. Geologic and fossil evidence indicates that the oldest rock in the area is sedimentary, the youngest is the Katahdin granite, and the volcanic rock is intermediate in age. The layered rocks are folded and faulted by compression acting in the earth's crust. The compression occurred before the intrusion of the Katahdin granite. The distribution of various bedrock types is shown on the accompanying geologic map.

The record of geologic history between the Devonian and the Pleistocene is blank. During most of this time, the area probably was out of water and undergoing erosion. The mountains are formed of the more resistant igneous rocks - the Katahdin granite and Traveler rhyolite; the softer sedimentary rocks were reduced by erosion to low hills. The present elevation of Mt. Katahdin and the other mountains above the surrounding lowlands represents the result of nearly 300 million years of erosion, probably attained during the middle or late Cenozoic, but before the ice age. The landscape in the Katahdin area at the beginning of glaciation was approximately that of today, and the results of glaciation have merely modified the preglacial landscape.

A section is devoted to glacial geology and, more specifically, to the record of glaciation in Baxter State Park. This section discusses: glaciers and how they form, features produced by glacial erosion, features produced by glacial deposition, and a sequence of events inferred from the glacial geology of Baxter State Park.

The final part is devoted to miscellaneous features which are not clearly related to either bedrock geology or glacial geology. Potholes, streams and rivers, South Branch Pond delta, landslides, features related to climatic conditions, patterned ground, rock streams, arctic plant and animal life, and hurricane blowdown are discussed briefly.--L. M. Dane.

3-3957. Kansas Geological Society. GUIDEBOOK, TWENTY-SIXTH ANNUAL FIELD CONFERENCE. NORTHEASTERN MISSOURI AND WEST CENTRAL ILLINOIS: 168 p., 74 figs., incl. illus., maps, secs., charts, diags., 3 pls., The Society, 508 East Murdock, Wichita, Kansas, Sept. 1961, refs.

This field conference was conducted in cooperation with the Missouri Geological Survey and the Illinois Geological Survey. Following the 2 road logs for the conference, 11 technical papers were presented. They are listed below in the order in which they appear in the guidebook.

The Lincoln Fold of Northeastern Missouri, by John W. Koenig.
The Lincoln Fold in Lincoln, Pike, and Ralls Counties, Northeastern Missouri, by Henry S. McQueen, and others.
The Cap au Gres Fault, by Virgil B. Cole.
Basal Relationships of the Mississippian in Northeastern Missouri, by Maurice G. Mehl.
Sporangites as "Horizon Markers," by Maurice G. Mehl and Bernard Shaffer.
The Kinderhookian Series in the Mississippi Valley, by Charles Collinson.
Conodont Faunas from the Louisiana and McCraney Formations of Illinois, Iowa, and Missouri, by Alan J. Scott and Charles Collinson.

Lower Osagean Stratigraphy of East-Central Missouri, by Don L. Kissling.
The Middle Mississippian Series (Osagean and Meramecian) of Northeastern Missouri, by Alfred C. Spreng.
Pennsylvanian Geology of the Lincoln Fold, by Walter V. Searight and Thomas K. Searight.
Iron and Lead Exploration in Missouri, by William C. Hayes.

3-3958. Kennedy, Richard R. GEOLOGY BETWEEN PINE (BULLION) CREEK AND TENMILE CREEK, EASTERN TUSHAR RANGE, PIUTE COUNTY, UTAH: Brigham Young Univ., Dept. Geology, Brigham Young Univ. Research Studies, Geology Ser., v. 7, no. 4, 58 p., 2 figs., geol. map (in pocket), 12 pls., table, 1960, 36 refs.

The mapped area is located immediately S. of Marysvale, Piute County. The area ranges in altitude from 5,825 ft. to 11,000 ft. and contains 4 principal physical divisions. Sedimentary rocks total approximately 6,100 ft. in thickness and range from middle Pennsylvanian to Tertiary-Quaternary in age. Paleozoic rocks are predominately carbonate. Mesozoic rocks are predominately sandstone and shale, with a subordinate amount of carbonate and conglomerate. Tertiary-Quaternary sediments are mainly conglomerate and alluvial debris. Some revisions of the local stratigraphic nomenclature are proposed with the introduction, into this part of Utah, of the terms Callville limestone, Oquirrh formation, Toroweap formation, and Winsor formation. A new formation, the Tushar conglomerate, is named.

It is postulated that during late Tertiary time a lake was formed in the vicinity and S. of Marysvale as a result of a damming action on the Sevier River by volcanic flows and faulting in the Antelope Range.

Volcanic igneous rocks in the area total approximately 3,500 ft. in thickness and range from middle Tertiary to Quaternary(?) in age. Four phases of volcanic activity are recognized: 1) Bullion Canyon series, consisting mainly of andesites, latite, tuff, and agglomerate; 2) transitional series, consisting of tuff and latite; 3) Mount Belknap series, consisting of rhyolite, tuff, and latite; 4) late Tertiary-Quaternary(?) basalt. The Bullion Canyon series is subdivided into 3 units, based on petrologic and petrographic observations.

The area exhibits structural features that are characteristic of the Colorado Plateau province to the E., namely flat-lying sedimentary formations, and the Basin and Range province to the W., namely tilted fault blocks. N.-S. folds and faults are prominent, but also present are less obvious NW.-SE. and NE.-SW. trends.

Known ore deposits, except the alunite occurrences, are presently of minor importance. In the past, Au, Ag, Hg, Pb, Cu, Zn, and alunite have been economically exploited. Ore deposits consist of vein and replacement types. Localization appears to have been controlled mainly by favorable Paleozoic carbonate beds, fault intersections, fracture patterns, and sedimentary-igneous contacts. Open space filling has been important as a mode of ore deposition. --Auth.

3-3959. Giudice, Daniele del. APUNTES SOBRE LA GEOLOGIA DEL DEPARTAMENTO DE NUEVA SEGOVIA [Notes on the Geology of Nueva Segovia Department]: Nicaragua, Servicio Geol. Nac., Bol. no. 4, p. 17-37, illus., map (in pocket), scale 1:200,000, 1960, 6 refs.; text in Spanish.

The area studied covers about 4,125 km.^{2}, located between 14° and 14°30'N., 86°15' and 87°10'W., along the Honduras frontier. Most of the area is underlain by the Nueva Segovia metamorphics of unknown (either Paleozoic or Mesozoic) age. The metamorphics consist of gray to gray-black phyllites of sedimentary origin, locally graphitic or quartzose, and slightly higher grade gray to gray-green sericitic schist, mica schist or mica phyllite and marbles. These higher grade metamorphics are concentrated in aureoles surrounding intrusive granitic batholiths. Aplite dikes and hydrothermal quartz veins also cut the metamorphics. Unconformably above the Nueva Segovia metamorphics is the Totogalpa formation, up to 100 m. thick, consisting of quartzose red conglomerates, breccias, and sandstones with siliceous cement. The age of this series is unknown. They are similar to the Paleozoic Santa Rosa red beds of Guatemala, the Mesozoic Metapán red beds of El Salvador and Guatemala, and red beds in Jinolega Dept., Nicaragua. The red beds of Jinolega Dept. are interbedded with miliolid limestones carrying Orbitolina texana of Albian age. The possibility is suggested that the Nueva Segovia metamorphics and the Totogalpa formation are of Mesozoic age, the latter possibly late Mesozoic and/or early Tertiary. Unconformably above the Totogalpa is a Tertiary andesite-basalt sequence. The youngest strata are alluvium. Mineral deposits in the region are associated with hydrothermal quartz veins related to the granitic batholith. Au, Ag, Mo, and W offer the best commercial possibilities. Some Zn and pyrite are also present.--A. A. Meyerhoff.

3-3960. Zoppis Bracci, Luigi, and Daniele del Giudice. RECONOCIMIENTO GEOLOGICO DEL VALLE DE PUNTA GORDA [GEOLOGICAL RECONNAISSANCE OF PUNTA GORDA VALLEY]: Nicaragua, Servicio Geol. Nac., Bol. no. 4, p. 61-83, 8 illus., geol. map (in pocket), scale 1:200,000, 1960, 4 refs.; text in Spanish.

Punta Gorda valley lies mainly in Zelaya Dept. adjacent to the Atlantic coast. Probably the oldest sediments identified are a Tertiary marine sequence of hard, gray sandy shales with greenish breccias, some organic limestones and minor tuffaceous shale. The limestones contain miliolids, ostracods, and other fossils. Probably younger than the marine sequence is a series of plant-bearing lacustrine siliceous sandstones and detrital limestones containing a fresh-water fauna, probably no older than Miocene. Most of the area is blanketed by an extensive volcanic complex composed of almost flat-lying andesitic and basaltic flows, porphyries and tuffs. The range in composition of the flows is from rhyolite through basalt. Within the volcanics are 2 fossil-bearing horizons, 1 marine. The marine fossils prove a Tertiary age, probably Miocene or younger. No interesting or economic mineral deposits were found.--A. A. Meyerhoff.

See also: Geologic Maps 3-3945, 3-3950; Stratigraphy 3-4053, 3-4054, 3-4055; Geophysics 3-4084, 3-4105, 3-4121; Geochemistry 3-4139; Sedimentary Petrology 3-4194; Geohydrology 3-4201, 3-4217; Engineering Geology 3-4288.

3-3961. Tanner, William F. AN ALTERNATE APPROACH TO MORPHOGENETIC CLIMATES: Southeastern Geology, v. 2, no. 4, p. 251-257, 3 figs., June 1961, 10 refs.

The relationships between climate and landform are not yet completely clear. There seem to be, however, 4 main climate types, as far as landforms are concerned: wet; warm dry (arid); cold dry; and temperate. The fourth of these occupies a middle position between the 3 extremes. In order to clarify these relationships, the station data (from many parts of the world) are plotted on a chart whose coordinates are precipitation and potential evaporation. The latter is adopted, as adequate for the purpose, despite its known shortcomings. The result, like other similar charts, does not define precisely all morphogenetic regions. It is presented, however, as a basis for additional investigation.--Auth.

3-3962. Ewing, Maurice, and William L. Donn. PLEISTOCENE CLIMATE CHANGES (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 931-941, 5 figs., Toronto, University of Toronto Press, 1961) 38 refs.

It is postulated that the ice-free condition of the Arctic Ocean is the direct cause of Pleistocene ice ages in the northern hemisphere. Evidence indicating an open Arctic Ocean is found from a study of thermal gradients, postglacial uplifts, arctic seismicity, and the heat budget of the arctic area. An attempt is made to explain the Pleistocene climate changes in terms of the alternations of ice-free with ice-covered states of the Arctic Ocean.--Auth.

3-3963. Sukachev, V.N. RELATIONSHIP OF BIOGEOCOENOSIS, ECOSYSTEM, AND FACIES: Pochvovedeniye, Soviet Soil Sci., in translation, 1960, no. 6, p. 579-584, pub. 1961, 39 refs.

Separate natural unities result from the closer relations among a given group of natural phenomena than to relations among other phenomena and objects. One of these unities is that of the plant and animal world with the portion of the atmosphere, earth's weathering crust, and soil which they inhabit. The commonest terms suggest for these unities are "ecosystem" and "biogeocoenosis."

An ecosystem has been defined as a natural unit of living and nonliving elements which interact to create a stable system, and in which a regular exchange takes place between living and nonliving matter. The definition and concept of ecosystem are vague and ambiguous.

The term biogeocoenosis arose in the U.S.S.R. and may be defined as a portion of the earth where a biocoenosis and the parts of the atmosphere, lithosphere, hydrosphere, and pedosphere responsive to it are homogeneous and closely related, so that they form in the aggregate a single independent complex.

The term "facies" has been used nearly synonymously for biogeocoenosis by some workers. Facies is widely used in geology, although the concept is not always understood in the same way. A facies may be associated with a particular biogeocoenosis, but it is not a biogeocoenosis.

The study of biogeocoenosis encompasses more than the study of its individual parts and requires a method utilizing physics, chemistry, mathematics, meteorology, soil science, hydrology, and biology.--F. R. Hall.

3-3964. Arnold, K. C. AN INVESTIGATION INTO METHODS OF ACCELERATING THE MELTING OF ICE AND SNOW BY ARTIFICIAL DUSTING (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 989-1013, 26 figs., 3 tables, Toronto, University of Toronto Press, 1961) 23 refs.

During the summer of 1959 the author conducted experiments on snow, sea ice, and lake ice surfaces in an attempt to accelerate their rate of melting by artificial dusting. Seven different types of materials were used, differing in particle size and in the presence or absence of salt or sand. Each of these materials was spread in amounts of 100, 300, 500, 700, and 1,000 g. on squares 1 sq. m. in area. This gave 35 squares to study on each of the snow, sea ice, and lake ice surfaces.

During the summer, repeated measurements were taken in each of these squares, using a level and rod to measure the departure of each square from a system of reference stakes. A comparison was also made with untreated areas, which served as a control. Cores and stereoscopic photographs were taken in each square of the sea and lake ice surfaces, illustrating the penetration of the dust into the ice surface. Meteorological readings are available at 3-hour intervals in the areas studied.

The results are discussed and some comparisons made between the different surfaces and materials. Former practical applications of this method are referred to, and possible future applications are suggested.--Auth.

3-3965. Smith, David D. SEQUENTIAL DEVELOPMENT OF SURFACE MORPHOLOGY ON FLETCHER'S ICE ISLAND, T-3 (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 896-914, 14 figs., table, Toronto, University of Toronto Press, 1961) 18 refs.

Fletcher's Ice Island is composed primarily of iced firn containing numerous elongate, lensoid bodies of old lake ice formed during the build-up of the parent Ellesmere ice shelf. The parallelism of these bodies imparts a pronounced structural grain to the island. Overlying the 2 bedrock ice types are modern lake ice pads formed at the close of an unusually short, cool summer within the last 5 years.

Ablation causes a progressive, though noncyclic, sequential development of surface forms characterized by repeated inversion of relief. Ice units having higher albedo values and more favorable crystal structure are etched into prominence by differential solar weathering.

The surface of the island has a gently undulating topography made up of numerous broad, parallel ridges and intervening narrow but shallow valleys; together, these forms compose the first-order relief. Second-order relief features are present on the first-order ridges. These consist of 1) long narrow ridges underlain by bodies of resistant old lake ice, 2) inter-ridge valleys and lowlands underlain by nonresistant iced firn, and 3) mesalike forms which develop on the modern lake ice pads. A variety of third-order or microrelief forms is also present.

First-order ridges develop in areas where

resistant second-order ridges are concentrated; first-order valleys form in intervening areas where second-order ridges are more widely spaced. Second- and third-order relief is the direct topographic expression of differential ice resistance; first-order relief is the indirect topographic expression of this differential resistance. Geomorphically, all 3 orders of relief are a product of structural control.--Auth.

3-3966. Fristrup, Børge. DANISH GLACIOLOGICAL INVESTIGATIONS IN GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 735-746, 9 figs., Toronto, University of Toronto Press, 1961) 9 refs.

From the Geographical Dept., University of Copenhagen, glaciological investigations were carried out in Greenland in the years 1956-1958 as part of the Danish program for the IGY. Four specially selected glaciers in N., S., W., and E. Greenland were studied in relation to glacial morphology, glacial meteorology, and oscillations in relation to change of climate.

A very broad geographical variation was found especially concerning the temperature in the ice. The glaciers in northern Greenland are real polar, while the glaciers in most parts of southern and central Greenland are temperate, according to the definition by Hans Ahlmann, with temperatures very near zero during most of the year. Therefore the glaciers in southern Greenland will also be very sensitive to increasing temperature, while the glaciers in N. Greenland react only very slowly to rise in temperature. In accordance with this it has been found that the glaciers in Thule district started to retreat later than in S. Greenland. Of special importance is the great area of superimposed ice.--Auth.

3-3967. Nobles, Laurence H. SURFACE FEATURES OF THE ICE-CAP MARGIN, NORTHWESTERN GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 752-767, 16 figs., Toronto, University of Toronto Press, 1961) 19 refs.

The gross configuration of the Greenland ice-cap in marginal regions is determined by the relation between local accumulation and ablation, by the configuration of the underlying bedrock topography, by the rate of ice movement, and to a certain extent by the past history of the ice-cap. Local features of the ice surface develop within the framework of this gross configuration and are controlled by the thermal regimen of the ice, the underlying ice structure, and the nature of the accumulation and ablation régime.

The ice margin is formed by large outlet glaciers, small valley glaciers, ice cliffs, steep ramps, and gentle ramps. The melt zone is characterized by surface run-off, forming such features as slush avalanches, algal pits, and an integrated drainage pattern.

The surface of the wet firn zone is characterized in summer by very soft and sticky granular firn. Crevasses are particularly dangerous in this zone as they are always wholly or partially bridged by firn.

The surface of the dry snow zone, which forms the interior of the ice-cap, is marked by sastrugi and other features of wind-drifted snow.--Auth.

3-3968. Hattersley-Smith, G. SOME GLACIOLOGICAL STUDIES IN THE LAKE HAZEN REGION OF NORTHERN ELLESMERE ISLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 791-808, 9 figs., 2 tables, Toronto, University of Toronto Press, 1961) 19 refs.

Glaciological research on the ice-cap and glaciers to the N. of Lake Hazen in northern Ellesmere Island was one of the main objectives of the Canadian IGY expedition to the area in 1957-1958. The work was concentrated on Gilman Glacier, but surveys extended over the ice-cap from Clements Markham Inlet in the NE. to Tanquary Fjord in the SW. Studies of accumulation and ablation indicated a budget deficit of about 60% for Gilman Glacier and its accumulation area for the year 1957-1958; a budget deficit which was appreciably greater in 1956-1957; and from preliminary data a smaller budget deficit in 1958-1959. At the highest level of the ice-cap (1,800 m.) the mean annual accumulation over the last 20 years is estimated at 12.8 $gm.cm.^{-2}$; the mean height of the equilibrium line is about 1,200 m. The main glaciers from the high ice-cap are thinning slightly in their lower reaches, but their snouts are not receding; it may be expected that similar glaciers elsewhere in Ellesmere Island and in Axel Heiberg Island are reacting in the same way to the present climate. Marginal features in the ablation area of Gilman Glacier provide some evidence of recent thinning and of recession from the rock walls of the glacier. S. of the main ice-cap, small local ice masses, which do not rise above about 1,200 m., and associated glaciers are both thinning and receding at their edges year by year. It seems certain that thinning and recession is ocurring on small, low-level ice-caps throughout the Queen Elizabeth Islands.--Auth.

3-3969. Davies, William E. GLACIER CAVES IN SVARTISEN, NORWAY: Natl. Speleol. Soc., Bull., v. 23, pt. 2, p. 75-76, 3 illus., July 1961.

Discusses caves in the edge of the Østerdalsisen outlet glacier in the Svartisen ice field just N. of the Arctic Circle. Along the northern part of the glacier front the caves are regular melt channels. Their dimensions and general features are described briefly. A different kind of cave has formed along the S. part of the glacier front. It is cut in bedrock rather than developed within the glacier by meltwaters. The cave is a declivity, a former marginal channel, that was overriden by the glacier.--L. M. Dane.

3-3970. Carey, S. Warren, and Naseeruddin Ahmad. GLACIAL MARINE SEDIMENTATION (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 865-894, 8 figs., Toronto, University of Toronto Press, 1961) 31 refs.

Processes and terminology of ancient glacial sedimentation have been based on Quaternary terrestrial glacial phenomena, although such terrestrial deposits are likely to be geologically ephemeral. The contemporary marine glacial sediments on the shelves that may be buried in due course under other sediments are more likely to survive through geological periods, but those incorporated in currently active geosynclines (such as those in Alaskan waters) have the best chance of survival through geological eras. Hence study of marine glacial sedimentation, rather than current terrestrial forms, is essential for the recognition and analysis of ancient glaciations.

Profoundly different types of behavior and marine sedimentation are predicted according to whether the base of the sea-going glacier is colder than freezing

point or is permeated by melt-water in the region where it becomes buoyant. Wet-base glaciers have no marked change of surface altitude where they become buoyant; they produce great thicknesses of unfossiliferous tills that may have occasional sand or mud interbeds, and these give place seawards to marine sands and silts with few erratics, interbedded with frequent turbidity current deposits and occasional submarine flows of till-like material containing abundant glacially-striated erratics. Dry-base glaciers have a marked change of surface altitude, forming ice mountains rising from the line of buoyancy; they produce little in the way of tills but yield marine pebbly mudstones and siltstones, and the associated sediments have a high lime content grading into limestones that may contain dropped erratics; they may be associated with dark pyritic mudstones with calcareous concretions and large glendonites (calcite pseudomorphs after glauberite). Glaciers of these 2 types are identified in Antarctica, and sediments of the 2 types are found in the Tasmanian Permian system and also in the marine Pleistocene sediments of Middleton Island in the Gulf of Alaska.--Auth.

3-3971. Krinsley, D. B. LATE PLEISTOCENE GLACIATION IN NORTHEAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 747-751, 3 figs., Toronto, University of Toronto Press, 1961) 6 refs.

Early Pleistocene glaciations of Greenland extended far into areas now covered by sea; only later Pleistocene glaciations are recorded by deposits on present land areas.

Ice-free land in NE. Greenland between J. P. Koch fjord and Dijmphna sound is mantled with glacial drift which is truncated near the sea by marine terraces now more than 200 m. above sea-level. Aerial reconnaissance, photo interpretation, and recorded ground observations permit delineation of surficial deposits.

Modified moraine cut locally by marine terraces abuts less-modified moraine near Deichmans Oer in Hagens fjord. Moraines near the entrance of Independence and Danmarks fjords are comparable to the less-modified moraine in topographic expression, degree of drainage integration, and relation to the present ice fronts. Less extensive moraines, modified locally by marine erosion, occupy fjords, valleys, and adjacent highlands.

Fresh moraines adjacent to the ice-cap front indicate recent advances. Currently the main ice-cap and isolated ice-caps are receding.--Auth.

3-3972. Craig, Bruce G., and John Gladstone Fyles. PLEISTOCENE GEOLOGY OF ARCTIC CANADA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 403-420, 6 figs., Toronto, University of Toronto Press, 1961) 33 refs.

Continental ice-sheets formerly covered all of arctic Canada E. of the Cordillera except some of the western Queen Elizabeth Island, where conclusive evidence of more than local glaciers has not been found. The Mackenzie delta, western Banks Island, and southern Melville Island have been glaciated by the Laurentide ice sheet but may lie beyond its Wisconsin margin. Interglacial deposits are widely distributed in the Mackenzie delta. The fluvial Beaufort formation, of Pliocene or early Pleistocene age, borders the Arctic Ocean from Meighen Island to southern Banks Island and may be present in the Mackenzie delta. The outermost NW. part of the area covered by the Wisconsin Laurentide ice-sheet is characterized by large moraines and prominent lobation of the ice margin. Inside this zone drumlins, eskers, etc. form a radial pattern recording retreat of the ice-margins towards the Keewatin ice-divide, which was ice-free about 7,000 years ago. The limit of postglacial marine submergence increases in elevation from the periphery to the interior of the area covered by the Laurentide ice-sheet. In the NW. isostatic adjustment was complete before final eustatic rise of sea level.--Auth.

3-3973. Miller, Maynard M. A DISTRIBUTION STUDY OF ABANDONED CIRQUES IN THE ALASKA-CANADA BOUNDARY RANGE (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 833-847, 6 figs., 2 tables, Toronto, University of Toronto Press, 1961) 15 refs.

The distribution, orientation, and frequency patterns of 218 cirques in the northern Boundary Range, Alaska-Canada, are analyzed. The mean elevation of the lowest ice-filled basins is 3,500 ft. In the valleys not formerly glaciated by trunk glaciers from the Wisconsinan Cordilleran ice-sheet, abandoned cirques occur in a repeated 5-fold sequence. The mean elevations of these cirques, or cirquelike basins, are: 350, 1,100, 1,750, 2,450, and 3,150 ft. The standard deviation in each system is small, and the effect of orientation appears to be random. There is no apparent evidence of regional control by lithology, bedrock structure, or preglacial topography. The frequency distribution, therefore, suggests that the cirque levels relate to former névé lines. An apparent correlation of cirque pattern with a sequence of other erosional forms in the main valleys of the range strengthens the inference of relation to Wisconsinan glacial stages. The study suggests that, during the late Pleistocene, glaciers in this maritime region were uniquely sensitive to climatic change.--Auth.

3-3974. Holmes, G. William, and Charles R. Lewis. GLACIAL GEOLOGY OF THE MOUNT CHAMBERLIN AREA, BROOK RANGE, ALASKA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 848-864, 8 figs., 2 tables, Toronto, University of Toronto Press, 1961) 16 refs.

Glaciers originating in the Franklin Mountains, northeastern Brooks Range, advanced in 4 major Pleistocene glaciations and in 2 minor Recent fluctuations. The oldest advance, the Weller glaciation, moved across the foothills to the S. flank of the Sadlerochit Mountains; it is recorded by scattered quartzite and granitic erratics on bedrock ridges and smooth sheets of till on the middle and lower slopes that have been profoundly modified by frost action and gravity and mixed with silty colluvium. Next, the Chamberlin glaciation deposited till sheets and outwash aprons with well-defined topographic expression. Although the end moraine of this glaciation is mappable and the moraine-outwash relation is generally preserved, minor topographic features have disappeared. The less extensive Schrader glaciation is represented by ridged, lobate end moraines, some of which enclose Lake Schrader. These moraines are marked by a few shallow ponds and low hillocks and by a widely-distributed, well-developed assortment of frost features. The last major advance, the Peters glaciation, did not extend beyond the mountain front and formed fresh, bouldery, steep-sided

lateral and end moraines. Frost features are rare or absent on Peters moraines. Modern glaciers have formed 2 groups of moraines: a slightly weathered single or double moraine several hundred yards from the ice front and a very fresh moraine in contact with the ice.--Auth.

3-3975. Melton, Mark A. MULTIPLE PLEISTOCENE GLACIATION OF THE WHITE MOUNTAINS, APACHE COUNTY, ARIZONA: Geol. Soc. America, Bull., v. 72, no. 8, p. 1279-1281, map, Aug. 1961, ref.

Field evidence indicates 2 episodes of glaciation in the White Mountains, separated by a considerable time gap represented by deep weathering of the older glacial material, stream entrenchment, and outpouring of basalt and cinders over the area. The snow-level depression at the time of the younger glaciation was 2,700±640 ft. below the estimated, modern snow level.--Auth.

3-3976. Janssen, Raymond E. THE EXTENT OF TEAYS LAKE: West Virginia Acad. Sci., Proc., v. 31/32, p. 47-48, 1959-1960, 6 refs.

On the basis of study of old shorelines and varved-clay deposits, it is concluded that glacial Teays lake, probably of Kansan age, extended from the glacial front N. of Chillicothe, Ohio, to Hawks Nest, West Virginia, a distance of about 250 mi. The lake was largely confined to the present Teays river valley being 1 1/2 to 3 mi. wide in its major portion.--M. Russell.

3-3977. Davies, William E. SURFACE FEATURES OF PERMAFROST IN ARID AREAS (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 981-987, 5 figs., table, Toronto, University of Toronto Press, 1961) 4 refs.

Most permafrost studies in America have been in wet soils. In N. Greenland, at Brønlunds fjord and Polaris promontory, cursory examination of permafrost in extremely arid areas shows that permafrost conditions contrast greatly with those in areas of wet soils such as on the arctic slope of Alaska.

Soils in the areas studied are silty clay, sand, and gravel. The physical characteristics of the active zone are similar to those in other areas of permafrost. The active zone extends 20 to 40 in. at the maximum in summer. Soil temperature at the surface is 40 to 46°F. Temperatures in the active zone in gravel grades from freezing at the permafrost layer to 37 to 42°F. 6 in. below the surface. Soil moisture is 1.2 to 7.8%; the higher content is close to the permafrost boundary. Temperature in silty clay soil is similar to that in gravel; moisture content is 1 to 11% near the surface and 8 to 22% just above permafrost. The top of the permafrost is uniform with flat or gently sloping surface. Ice wedges and related features are not extensive.

The surface shows few features characteristic of permafrost or severe frost action. In the silty clay, heave and slump are lacking. The only surface markings are many small, polygonal, desiccation cracks. Flats underlain by gravel have irregular polygons with broad, shallow depressed edges; shrinkage cracks filled with fine sand are in the sand and gravel. Permafrost in arid areas produces an increase in soil compaction, uniform continuing moisture content, and a high-shear strength.--Auth.

3-3978. Legget, Robert F., and others. PERMAFROST INVESTIGATIONS IN CANADA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 956-969, 3 figs., table, Toronto, University of Toronto Press, 1961) 42 refs.

A knowledge of permafrost distribution is of vital concern to the practicing engineer and geologist. The Division of Building Research is engaged in mapping permafrost in Canada on the basis of continuous and discontinuous zones. The information obtained to date has been compiled mainly from direct field observations, and the mapping of permafrost by such methods is a long-term project. Recently the Division has initiated a study of climatic and terrain factors affecting the existence of permafrost in specific locations as a means of improving the ability to predict permafrost conditions. The basic energy factors affecting permafrost distribution cannot be measured with sufficient accuracy to determine the thermal condition causing permafrost which is the integrated effect of climatic and terrain factors over a long period. The objective of this study, therefore, is to investigate the thermal characteristics of the terrain components and to seek correlations between these, the climatic factors, and the distribution of perennially frozen ground.--Auth.

3-3979. Cook, Frank A. PERIGLACIAL PHENOMENA IN CANADA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 768-780, table, Toronto, University of Toronto Press, 1961) 99 refs.

The study of periglacial geomorphology has made great advances throughout the world in recent years. However, in Canada periglacial research is still in an early stage, having emerged as a field of study only in the past decade. Since 1956, Canada has been a member of the Commission on Periglacial Geomorphology of the International Geographical Union, and recently a Canadian National Committee of the Commission was formed to coordinate research in Canada in periglacial geomorphology.

The opening of the Canadian N. since World War II has given geologists and geographers a vast new area in which to conduct field surveys. This same vastness accounts, perhaps, for the paucity of detail on the distribution of periglacial phenomena in Canada, for most field surveys are in the nature of a general reconnaissance. In addition, there are very few scientists actually working on periglacial problems. Large areas still remain unreported. Research is further complicated by the small scale of the map coverage. For most northern areas adequate base maps have been published only during recent years.

In Canada the emphasis on the type of periglacial phenomena studied has differed from that in other countries. Alpine and fossil forms have received little attention; the main interest has been such active forms as patterned ground and permafrost.

The present paper attempts to document references in the literature to periglacial phenomena in Canada. Many well-known features are absent because as yet they are undocumented.--Auth.

3-3980. Kelly, William C., and James H. Zumberge. WEATHERING OF A QUARTZ DIORITE AT MARBLE POINT, McMURDO SOUND, ANTARCTICA: Jour. Geology, v. 69, no. 4, p. 433-446, 7 figs., 2 pls. (1 col.), 4 tables, July 1961, 9 refs.

Methods established by Goldich in his classic study

of rock weathering have been applied with some modifications to analysis of a weathered rock series collected in the Antarctic. Exposures of a fine-grained quartz diorite exposed at Marble Point, McMurdo Sound, were selected for study because they appeared to have undergone extensive chemical weathering beyond the effects to be expected in a region of such extreme cold and aridity. The light-gray, well-knit rock is altered in its most weathered form to a rich brown sand with angular particles as small as 0.003 mm.

Complete chemical analyses of the rock in 6 of its weathering stages were obtained, and the trends established by these data were correlated with the mineralogic changes.

Contrary to the impressions gained in the field, the bulk chemical and mineralogic composition of this rock has remained constant throughout the observed weathering sequence. There is no substantial change in alumina, combined silica, soda, lime, or potash which are normally sensitive indicators of chemical action. No clay forms in the weathering process.

The only appreciable change involving an original constituent of the rock is the progressive oxidation of ferrous Fe in pyrrhotite and biotite and the resulting formation of limonite which is responsible for the pronounced difference in color of the physically weathered debris. Seventy percent of the original ferrous oxide is lost, and 45% of total iron oxide is leached from the rock.

Small amounts of halite deposited by evaporation of sea spray and native S, presumably derived from volcanic fumes of Mt. Erebus, are found in the more-weathered materials at Marble Point. Their abundance relates to weathering only in that the disintegrated rock is physically more favorable to accumulation of these exotic substances.

Oxidation of the native S has contributed acid to the surface debris and thereby promoted rapid decomposition of pyrrhotite in the fresh rock and the pronounced Fe staining in the weathered outcrops.

The maximum volumetric changes caused by oxidation and hydration of the original minerals is negligible, and it is concluded that the mechanism primarily responsible for the observed breakdown of the rock is the combined action of frost-wedging and the crystallization of salt in pores and crevices in the weathering rock.

Continuous records of the ambient air temperatures taken at Marble Point during the summers of 1957-1958 and 1958-1959 suggest that about 30 freeze-thaw cycles affect the site each year. However, on unclouded days rock-surface temperatures are considerably higher than air temperatures, and the number of freeze-thaw cycles in the rocks probably does not correspond to that indicated by air-temperature measurements.

This study began as an investigation of what appeared to be a case of strong chemical weathering in the Antarctic and has ended in providing quantitative proof of the predominance of physical processes, a predominance commonly accepted on qualitative grounds.--Auth.

3-3981. Rex, Robert W. HYDRODYNAMIC ANALYSIS OF CIRCULATION AND ORIENTATION OF LAKES IN NORTHERN ALASKA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1021-1043, 16 figs., 4 tables, Toronto, University of Toronto Press, 1961) 30 refs.

The systematic orientation of elliptical lakes occurring in the unconsolidated sediments of the Arctic Coastal Plain of Alaska has been attributed by some investigators to winds blowing along their major axes and by others to winds blowing along their minor axes. The application of hydrodynamic principles resolves this question in favor of orientation of the lake minor axis parallel to the dominant wind direction.

Details of predicting lake waves and computing longshore currents, orbital velocities associated with shoaling waves, orbital velocities required to move sediments, and equilibrium shoreline configurations are presented with an example for the Barrow area of Alaska. Data are provided so that the reader may repeat these computations for other cases. Although the area studied here is in the Arctic, the same hydrodynamic principles apply to oriented lakes, bays, and lagoons elsewhere in the world.

One may reverse this line of reasoning and utilize geomorphological evidence to make meteorological deductions. The details of Black and Barksdale's descriptions of the Alaskan lakes suggest that the summer intensity of the polar northeasterly winds is decreasing and that there has been a recent increase of southerly winds.--Auth.

3-3982. Woodward, Herbert P. A STREAM PIRACY THEORY OF CAVE FORMATION: Natl. Speleol. Soc., Bull., v. 23, pt. 2, p. 39-58, 5 figs., July 1961, 17 refs.

This theory attributes all caves to the sudden rearrangement of a specific drainage system, either by the piracy of a higher-level system by a lower-level system, or by the capture of surface drainage by underground circulation. Its distinctive feature is its association of the cave-forming process with the history of the adjacent surface drainage system, and that it regards a cave as a transitory or impermanent feature of stream development in the same category as a waterfall, a lake, or a river gorge.

The theory postulates a single stage (not cycle) of cave development although there must have been a necessary pre-cave epoch in which the bedrock acquired an incipient structural porosity along joints and fractures. The trigger which initiates cave development is the activation of swift flow at the water-table level, a situation which is normally absent and is likely to be brought about only by some relatively sudden event. Such causative events might be the fall of sea level; glaciation and ice melting; a major climatic change; acceleration or relocation of surface streams; or the break-through of some impervious barrier or retaining wall.

Although these causative events seem to be widely different, each one effects a significant change in the surface drainage pattern, resulting in stream rearrangement, rejuvenation, diversion or capture. On this account the theory is termed the "stream piracy" theory.--Auth.

3-3983. May, David V. SPELEOLOGY IN NEW ZEALAND: Natl. Speleol. Soc., Bull., v. 23, pt. 2, p. 31-38, 5 illus., 3 maps, July 1961.

The New Zealand Speleological Society was founded in 1949. At present there are 5 cave groups which are affiliated in the society. Karst areas are in the region of Te Kuiti, Port Waikato, Wairo, and Waipu on North Island and at Fox River, Lake Te Anau, Nelson, and other areas on South Island. The longest cave is Gardners Gut, 4 mi. long. The deepest is

Harwood Hole, near Nelson, 1,415 ft. deep. Scientific work is now developing and covers exploration for fossil remains, primarily moa bones, studies of arthropods and some surveying, hydrological research, and work on subterranean radio communication.--Auth.

3-3984. Geyl, W. F. MORPHOMETRIC ANALYSIS AND THE WORLD-WIDE OCCURRENCE OF STEPPED EROSION SURFACES: Jour. Geology, v. 69, no. 4, p. 388-416, 22 figs., July 1961, 53 refs.

A brief account of opposed schools of thought regarding erosion surfaces is given. It is suggested that the convex break of slope between the flatter part of one erosion surface and the marginal slope of the next lower surface is the main criterion for recognition, on contoured maps, of erosion surfaces. A method of altimetric (morphometric) analysis is described, and graphs for a number of Australian and other maps are presented. A recurring pattern, with some variations, is noted on the graphs. In some cases correspondence exists with levels mentioned in the literature of the area. It is suggested that stepped erosion surfaces, to perhaps 2,000 ft. and over, may be a world-wide feature in stable regions, despite the difficulty of explaining their apparent non-deformation. Baulig's suggestion of a measure of universality of geomorphic events is recalled.--Auth.

3-3985. Ruhe, Robert V., and others. PALEOSOLS OF BERMUDA: Geol. Soc. America, Bull., v. 72, no. 8, p. 1121-1141, 6 figs., 2 pls., 4 tables, Aug. 1961, 22 refs.

Sayles recognized 5 buried soils that stratigraphically separate eolianites and interbedded marine limestones in Bermuda. He considered that the paleosols represent interglacial ages or interstadials. Some soils were considered residual, and some accretionary. Estimates of time of weathering of residual soils were made by computing ratios of insoluble residues in parent eolianite to the overlying whole soil.

Field study shows that island-wide correlation of the paleosols may be tenuous. No available cuts permit direct tracing of soils. Buried soils cannot be dated unless superposition is shown, and only section McGall's Bay shows all 5 soils superposed; correlation with other sections is difficult.

The morphology, physical and chemical properties, and mineralogy (as determined by X-ray, DTA, and thin sections) of the paleosols show that Sayles' Shore Hills and St. George's soils have considerable soil development and may represent major stratigraphic breaks. They are not residual but have other materials incorporated in their uppermost parts. Thus, Sayles' time estimates are questionable. The Harrington, Signal Hill, and McGall's paleosols have only weak color profiles and slight accumulations of organic matter in their uppermost parts. The latter 2 soils may represent only local pauses in accretion during accumulation of the later Bermuda dunes.--Auth.

3-3986. Chizhikov, P. N. A MAP OF THE NATIVE SOIL-FORMING PARENT MATERIALS OF THE EUROPEAN PART OF THE USSR: Pochvovedeniye, Soviet Soil Sci., in translation, 1960, no. 5, p. 465-469, map, pub. 1961, 10 refs.

The map, as published in the U.S.S.R., has a scale of 1:5,000,000; but the map published in this translation has a scale of 1:17,400,000. The following data were used to construct the map: 1) individual district, region, and republic maps of the soil-forming parent materials compiled at different scales and published at different times; 2) maps of Quaternary deposits; 3) soil maps, particularly those that contain data on soil-forming parent materials; 4) various data from published sources and data on lithology from research reports on soil studies at experiment stations.

The map differs from maps showing Quaternary deposits because it shows primarily the lithology of importance for soil formation and shows only the thin layer of material at the very surface affected by soil-forming processes.

The original map shows 2-component parent materials, salinization, and other features. The "problematical" materials, the loessic and surface clay loams, are distinguished from the other materials according to texture (their content of silt particles) and are divided into 5 types according to carbonate content.--F. R. Hall.

3-3987. COASTAL GEOGRAPHY. A Report of a Conference Sponsored by the NAS-NRC Committee on Geography, Advisory to the Office of Naval Research, March 20-21, 1961: 17 p., Washington, D.C., National Academy of Sciences-National Research Council, 1961.

This report has been prepared by an ad hoc panel on Coastal Geography convened at the request of the National Academy of Sciences-National Research Council Committee on Geography, Advisory to the Office of Naval Research. The panel met under the chairmanship of Dr. Richard J. Russell at the Coastal Studies Institute, Louisiana State University, in Baton Rouge on 20-21 March 1961.

The purpose of the report is 3-fold: 2) to identify the coastal zone as an area requiring interdisciplinary research; b) to focus attention on what now appear to be major problems; and c) to suggest preliminary steps in the development of an integrated, national research program in Coastal Geography.

The ultimate goal of research in coastal geography is a basic understanding of the physical, biological, and cultural factors, individually and collectively, that combine to produce the complexes that give the coastal zone its distinctive characteristics and processes. A research program aimed toward this goal has several broad objectives: 1) characterization of coastal areas and environments, that is, the identification and categorization of those sets of factors that are distinctive and significant in the coastal situation; 2) understanding of relations and changes across the 3 major environmental interfaces of water, land, and air; 3) understanding of the physical, chemical, biological and cultural processes and interactions within the various coastal zone environments; 4) appraisal of the coastal zone for its use potential.--From introd. & p. 4.

The report consists of a summary of the scope and objectives of coastal geography; recommended research program in physical, ecological, and cultural coastal geography, and world-wide considerations; recommended facilities.

3-3988. Scholl, David W., and Cleo L. Sainsbury. MARINE GEOLOGY AND BATHYMETRY OF THE CHUKCHI SHELF OFF THE OGOTORUK CREEK AREA, NORTHWEST ALASKA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 718-732, 8 figs., 3 tables, Toronto, University of Toronto Press, 1961) 10 refs.

During July and Aug. 1958, the U. S. Geological Survey conducted geologic studies of the Chukchi shelf off the Ogotoruk Creek area on behalf of the U. S. Atomic Energy Commission.

Throughout the study, a NW. coastal current flowed past the area at an average velocity of 0.5 m.p.h. (0.8 km./hr.). Upwelling of cold subsurface water locally reversed or slowed this current.

For approximately 1 mi. from shore the bottom descends rather steeply but flattens at 40 to 45 ft., and gradients average 0°04' for the next 15 mi. A flat-bottomed trough, Ogotoruk seavalley, averaging about 6 ft. in relief extends for 15 mi. seaward of the mouth of Ogotoruk Creek.

The nearshore shelf (inner 2 to 4 mi.) is a wave-planed platform cut across rocks of different lithology. Much of the planation took place in Sangamon and pre-Sangamon time. Ogotoruk seavalley is a drowned Pleistocene subaerial valley.

Sediments on the nearshore shelf are in part ice-rafted rocks, but are chiefly slightly rounded gravel derived from submarine outcrops; a few areas of relict rounded beach gravels also occur. Sand and silt overlie the bottom near shore, in areas of submarine outcrops, and off coastal outcrops of clastic rocks. Gravel beaches of limestone, chert, and graywacke form much of the shoreline.--Auth.

3-3989. Carsola, Alfred J., and others. BATHYMETRY OF THE BEAUFORT SEA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 678-689, 9 figs., table, Toronto, University of Toronto Press, 1961) 14 refs.

Oceanographic studies of the Beaufort Sea were made from ice-breakers during the summers of 1951, 1957, and 1958. Numerous echo-sounding lines were made across the shelf and slope, and into the deep Canada basin. Between the Colville and Mackenzie River deltas, the shelf has a width of about 40 nautical mi. with a shelf edge as shallow as 35 fm. The upper slope is relatively steep; on the lower slope the inclination decreases as depth increases. The floor of the Canada basin near the continental slope is flat and featureless. E. of Barter Island, the slope character changes because of the presence of the Mackenzie River and the Mackenzie Sea valley. Still further E. lies Amundsen trough at the outer end of Amundsen Gulf. This trough is a feature of glacial origin and the westernmost unfilled trough of the Canadian Archipelago.

Sea-floor photographs on the slope and in the deep basin show a flat, featureless bottom without evidence of ice-rafted pebbles. --Auth.

3-3990. Stewart, Harris B., Jr., and others. EXPLORER BANK - A NEW DISCOVERY IN THE CARIBBEAN: Geol. Soc. America, Bull., v. 72, no. 8, p. 1271-1274, 4 figs., Aug. 1961, 2 refs.

Scientists on the U. S. Coast and Geodetic Survey Ship Explorer discovered and investigated an "atoll-like" bank rising from nearly 1,000 fms. to 15 fms. about 95 mi. off the Caribbean coast of Honduras. A towed magnetometer showed that the primarily calcareous bank has a core of igneous origin.--Auth.

3-3991. Nichols, Donald R., and Lynn A. Yehle. MUD VOLCANOES IN THE COPPER RIVER BASIN, ALASKA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1063-1087, 10 figs., 4 tables, Toronto, University of Toronto Press, 1961) 29 refs.

Two groups of mud volcanoes, consisting largely of clayey silt cones which discharge gas and highly mineralized water, occur within 15 mi. of Glennallen. The 4 cones of the Tolsona group range in height from 25 to 60 ft. and lie W. of the Copper River near coal-bearing rocks of Tertiary age. Three of these cones are active. They discharge methane and N gas and water composed of chlorides of Na and Ca. The 3 cones in the Drum group lie E. of the Copper River near the slopes of the volcanic Wrangell Mountains. They are 150 to 310 ft. high, and emit carbon dioxide gas and warm sodium chloride and bicarbonate waters.

The source of gas in the Tolsona group may be from buried marsh or coal deposits because the gas contains only a trace of carbon dioxide and lacks hydrocarbons heavier than methane. Gas from the Drum group probably emanates from volcanic sources. Water in Tolsona springs may be a mixture of meteoric, connate, and/or highly saline ground water; the Drum springs may also include small amounts of volcanic water.

Formation of the cones was by quiet intermittent accretion, and in the Drum cones, probably included eruptive phases. Most cones formed largely before or during the last major glaciation.--Auth.

3-3992. Stout, Wilber. SUNN HILL, GEOLOGY AND PHYSIOGRAPHY: West Virginia Acad. Sci., Proc., v. 31/32, p. 49-52, 1959-1960, 3 refs.

Sunn Hill, near Wheelersburg, Ohio, provides an ideal vantage point from which to see and interpret facets of geomorphological development of the Cincinnati, Ohio, and Teays rivers and Pleistocene geology of the area. The Minford silt of the Teays basin accumulated in quiet or ponded water indicating a glacial-lake environment.--M. Russell.

3. STRUCTURAL GEOLOGY

See also: Stratigraphy 3-4018, 3-4030, 3-4032, 3-4044, 3-4049; Geophysics 3-4131; Igneous and Metamorphic Petrology 3-4191.

3-3993. SOVIET CONSIDERS 5 EARTH PROBES: New York Times, v. 110, no. 37,850, p. 13, col. 1, Sept. 10, 1961.

Proposals were made at a meeting of the Ministry of Geology of the U. S. S. R. that the Soviet Union undertake to probe the earth's crust to depths of as much as 9 mi. in 5 separate localities: the Caspian Sea, Karelia, Urals, Caucasus, and the Kurile islands. Goals of the projects would be: to match the U.S. Mohole project, to establish the lowest limit of petroleum deposits by traversing a thick sedimentary sequence to bedrock, to traverse a granite-shield sequence, and to traverse representative sections within the Soviet Union.--M. Russell.

3-3994. Tomashevskaya, I. S. A STUDY OF THE SHEAR MODULUS FOR SAMPLES OF ROCKS UNDER HIGH CONFINING PRESSURES BY THE TWISTING METHOD: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 281-284, 6 figs., 2 tables, 14 refs.

A special device is described which enables the twisting of a sample under the conditions of high confining pressure. To make the experiments, rock samples were prepared 10 cm. long and 0.8 or 1.2 cm. in diameter with square heads on the ends 1.2 x 1.2 x 1 cm. in size. All the tests were made on samples that had been dried to a constant weight. Tests were performed on gabbrodiorite, diabase, basalts, serpentine, syenite, and marble. The descriptions of the diabase, serpentine, and gabbrodiorite are cited in the article. The experiment is described and results given in graphs and tables.--A. C. Sangree.

3-3995. McCallum, Henry D. THRUST FAULT EXPOSURE, EAST FRONT STREET, TYLER, TEXAS: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1406-1410, 4 figs., Aug. 1961, 8 refs.

Exposures of thrust and (or) reverse faults are rare in the Gulf Coastal Plain region. One such exposure, the only one personally accounted for by the writer, was uncovered by an excavation on East Front Street. Vertical displacement was 1 ft., 8 in. and horizontal displacement 4 ft. The thrust fault is 2 mi. SW. of the East Tyler salt dome; whereas the small vertical displacement appears to be of little significance, the thrusting itself is important.--F. E. Kottlowski.

3-3996. Vacquier, Victor, and others. HORIZONTAL DISPLACEMENTS IN THE FLOOR OF THE NORTHEASTERN PACIFIC OCEAN: Geol. Soc. America, Bull., v. 72, no. 8, p. 1251-1258, 4 figs., fold. chart, Aug. 1961, 11 refs.

A total magnetic intensity survey in the northeastern Pacific Ocean revealed a N.-S. pattern of magnetic anomalies, which is cut through by the Murray, the Pioneer, and the Mendocino faults. The amount of slip along these faults is measured by fitting the magnetic anomaly pattern across the faults. The combined left-lateral displacement across the Mendocino and the Pioneer faults is 1,420 km.--Auth.

3-3997. Norris, D. K. AN INTERSTRATAL PEEL ON MAVERICK HILL, ALBERTA: Alberta Soc. Petroleum Geologists, Jour., v. 9, no. 6, p. 177-191, 5 figs., June 1961, 17 refs.

A number of overturned sedimentary successions of both small and great areal extent have been mapped in the southeastern Cordillera of Canada. Some appear to have arisen through drag by an overlying thrust plate where the thrust is cutting rapidly up section through foot-wall strata. Under these circumstances part of the foot-wall succession is plowed forward and overturned to form an interstratal peel. The structure may be modified by later thrust faulting. The type example is on Maverick Hill in southwestern Alberta. Structures of comparable form in the southeastern Cordillera are known on Coal Mountain, British Columbia, and in front of the High Rock, Flathead, and Clark ranges in Alberta.--Auth.

3-3998. Kranck, Ernst H. GYPSUM TECTONICS ON AXEL HEIBERG ISLAND, NORTHWEST TERRITORIES, CANADA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 438-441, fig., Toronto, University of Toronto Press, 1961) 6 refs.

The tectonic style of the central parts of Axel Heiberg Island in particular is controlled by gypsum diapirs intruding along the axis of narrow anticlines. The synclines are generally broad with basalt in the upper layers. The folding is due to horizontal compression and also isostatic forces. The structure is compared with dome-basin tectonics in gneisses. --Auth.

3-3999. Kent, P. E., and W. A. C. Russell. EVAPORITE PIERCEMENT STRUCTURES IN THE NORTHERN RICHARDSON MOUNTAINS (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 584-595, 2 figs., table, Toronto, University of Toronto Press, 1961) 11 refs.

Two small areas of gypsum emplaced in Cretaceous rocks on the arctic slope of the northern Richardson Mountains, Northwest Territories, show steeply dipping shear structures and contamination by a wide range of foreign rocks, including several igneous types and a number showing hydrothermal alteration. The gypsum occurrences are interpreted as piercement domes of deep-seated origin, probably from a Cambrian horizon.

Periodical studies and chemical analyses provide no evidence of sodium chloride or indications of its former presence. There is no evidence of leaching, and the sheared gypsum appears to be representative of the throat accumulation, rather than caprock residue. This suggests that the diapir at depth may have been primarily of calcium sulfate.

Development of mobility in gypsum by igneous action is shown to be unlikely by field relations and by petrological evidence. Movement due to expansion on hydration of anhydrite to gypsum associated with hydrothermal activity remains an alternative possibility.

Recognition of an evaporite group low in the sedimentary column facilitates understanding of the Richardson Mountains tectonics, which show a pattern indicative of Abscherung relative to the crystalline basement rocks.--Auth.

3-4000. Beals, Carlyle S. A PROBABLE METEORITE CRATER OF PRECAMBRIAN AGE AT HOLLEFORD, ONTARIO: Ottawa, Dominion Observatory, Pub., v. 24, no. 6, p. 117-142, 2 illus. (in pocket), 18 figs., 6 tables, 1960, 33 refs.

A circular feature 1.46 mi. in diameter and 100 ft. deep located at 76°38' W. and 44°27'N. in southeastern Ontario has been investigated as a possible meteorite crater. Stereoscopic studies of aerial photographs in conjunction with geological and geophysical investigations indicated the presence of a circular depression in Precambrian rock filled in and covered over by Paleozoic sediments. Three diamond drill holes at distances of 1,400 ft., 2,500 ft., and 3,750 ft. from the center were sunk to see whether the depth below the sediments and the subsurface structure were consistent with a meteoritic origin. The results showed a depth and profile close to those predicted for a meteorite crater of the observed diameter. Below the sediments a thickness of several hundred feet of shattered and pulverized rock was found for which no adequate explanation has yet been found except that of meteorite impact and explosion.--Auth.

3-4001. Eardley, A. J. HISTORY OF GEOLOGIC THOUGHT ON THE ORIGIN OF THE ARCTIC BASIN (In: Raasch, Gilbert O., ed. Geology of the Arctic ...: v. 1, p. 607-621, 12 figs., Toronto, University of Toronto Press, 1961) 13 refs.

Schuchert considered the Atlantic Ocean basin a permanent feature of the earth's crust, and from his maps it would appear that he regarded the Arctic basin likewise.

Wegener, and Köppen and Wegener postulated the Arctic basin to have formed by the break-up of an original great continent, Pangaea, and the separation of North America from Eurasia. This would leave the basin floored with "sima" or the gabbroic layer of seismologists.

Shatsky considered the Arctic Ocean floor a sunken region and called it the Hyperborean shield. The concept was generally held by Russian geologists, but instead of a shield it was called a platform or massif.

Eardley concurred with the Russians and presented evidence from the surrounding continents that the basin was a sunken region. The broad shelves and relatively small size of the basin, the facing Precambrian shields, and the Paleozoic orogenic belts that project under the Arctic Sea suggested to him that it was once a land or shallow sea area, and beginning in Paleozoic time it began to sink. The common marine fossil faunas of North America and Eurasia are thus readily explained.

Oliver, Ewing, and Press studied the surface seismic waves in paths across the Arctic basin, and showed that the crust there was oceanic; no continental layer is present as required by the subsidence theory.

The Russians, through 3,000 depth measurements, discovered a ridge across the basin, some 7,000 to 9,000 ft. high, and named it the Lomonosov ridge or range. The range is in line with an orogenic belt through Ellesmere Island of North America and one in the New Siberian Islands of Siberia. Can the range be due to orogenesis of the oceanic crust, or is it a volcanic feature? Hakkel depicts it as a belt of Mesozoic folding. He also reports an active volcano on it.

Demenitsckya illustrated the seismic layering of the basin from Franz Josef Land to Alaska, including the Lomonosov ridge, and showed the crust to be oceanic with a local thickening under the ridge.

Carey has recently detailed what he calls the Alaskan orocline and Arctic sphenochasm by which the Arctic Ocean basin came into existence first as a crack as North America spread apart from Eurasia, and then by widening of the breach, like opening a pair of scissors, with the axis near the Alaska Range. This is basically the same idea as that of Köppen and Wegener.

The Lomonosov ridge trends normal to the breach of the drift theory, as does a Hercynian belt of orogeny on the European side of the ridge postulated by the Russians. It is along the basin on the European side and parallel with the Lomonosov ridge that Heezen and Tharp extend the Mid-Atlantic rift, which they interpret as a tensional feature.

It appears, then, that the Arctic Ocean basin is underlain by oceanic crust and that the subsidence theory is hardly tenable. The theory that the Lomonosov ridge is a fold belt conflicts with the theory that the adjacent basin is a rift belt, unless they are separated by an appreciable time interval. The fold-belt theory may also be incompatible with an oceanic crust.

Both the fold-belt and rift-belt concepts are difficult to place compatibly in the orocline version of continental drift.--Auth.

3-4002. Heezen, Bruce C., and Maurice Ewing. THE MID-OCEANIC RIDGE AND ITS EXTENSION THROUGH THE ARCTIC BASIN (In: Raasch, Gilbert O., ed. Geology of the Arctic.... v. 1, p. 622-642, 13 figs., Toronto, University of Toronto Press, 1961) 56 refs.

A belt of earthquake epicenters crosses the Arctic basin from the vicinity of the Verkhoyansk range of Siberia to the Spitsbergen-Greenland strait. Thence the belt continues through the Norwegian Sea, follows the central graben across Iceland, and joins the seismic belt of the Mid-Atlantic ridge. Investigations of the Mid-Atlantic ridge have shown that the earthquake epicenters do not scatter across the full width of the ridge but are limited to a central rift valley which is invariably found close to the axis of the ridge. The Mid-Atlantic ridge is found to be a short section of a world-encircling mid-oceanic ridge system which extends through the Indian and the South Pacific oceans.

Although the existence of an earthquake belt in the Arctic basin has been long recognized, the presence of a rifted ridge following this belt has not previously been claimed. The writers find that the soundings of Fram and Sedov, when reinterpreted in the light of the mid-oceanic ridge, are not unfavorable to this concept. The extension of this belt through the rift valleys of Africa and the central graben of Iceland suggests that extension is characteristic of the whole system. According to this line of reasoning, that portion of the Arctic basin between the Lomonosov ridge and the Eurasian continental shelf is growing wider.--Auth.

3-4003. Haller, John. ACCOUNT OF CALEDONIAN OROGENY IN GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 170-187, table, Toronto, University of Toronto Press, 1961) 44 refs.

In N. Greenland a short-lived geosyncline developed mainly in lower Paleozoic time. In the late Silurian, and perhaps in the Devonian as well, mountain-building succeeded the deposition of the sedimentary belt. The folding trends approach an E.-W. orientation. The occurrence of thrust planes and the style of folding indicate superficial tectonics with a distinct one-way drive towards the N.

The E. Greenland fold belt, probably initiated during Silurian time, shows a distinct westward drive; that is, towards the stable block. The belt developed during 3 phases of activity:

1) Caledonian main orogeny ((?)Silurian) affected the whole E. coast. Folding was a consequence of deep-seated mobility and strong migmatic action. In central E. Greenland where a vast sedimentary pile was lifted up, the crustal shortening appears to be inconsiderable. The course of the orogeny generally trends N.-S. In NE. Greenland tectonics caused by tangential pressure and crustal shortening prevail. In most places the orogenetically active tracts lie below the present exposure level and in the northmost part beyond the coast. From 76° to 82° N. the orogeny created a lineal thrustfold belt strictly directed NNE.-SSW.

2) Late Caledonian spasms are restricted to the territories S. of the 76°N. They can be dated Middle and Upper Devonian, in part.

In the latest stage of the main orogeny in central E. Greenland, the Caledonian chain was subjected to tension, which produced an extensive grabenlike basin lying between 72° and 74° N. The bordering stepfold systems run NNW.-SSE. The depression acted as a catchment basin for Old Red detritus.

The down-flexured belt and adjoining areas were dissected by an echelon fault belt directed NNE.-SSW. It caused an eastward inclined arrangement of steplike fault blocks.

Folding operated predominantly subsequent to the fracturing: i) In the northern heaved tract, deep-seated folding trending NW.-SE. took place. ii) Within the Old Red depression, 2 fold belt systems occur, 1 running NNW.-SSE. the other ENE.-WSW. Both systems are linked with granitic melts, which rose up syntectonically along shear planes. There is a close relationship between superficial folding, thrusting, and injected granite bodies. iii) The southern heaved tract, as far as we know at present, did not undergo any folding in late Caledonian time.

3) Minor succeeding episodes. Within the Old Red basin, subsequently filled up also by continental Carboniferous detritus, shallow disturbance took place in lower Carboniferous and Lower Permian time. The prevailing systems trend N.-S.--Auth.

3-4004. Haller, John. THE CAROLINIDES: AN OROGENIC BELT OF LATE PRECAMBRIAN AGE IN NORTHEAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 155-159, Toronto, University of Toronto Press, 1961) 13 refs.

Subsequent to the planation of the "shield" area in NE. Greenland a marginal strip of the stable region became strongly negative. Cover rocks (Thule group) accumulated in a geosynclinal structure running NNW.-SSE. The sandy upper part of these strata encroached upon the cratonic area far to the W. and to the S. as well. A later erupted basaltic magma penetrated these cover rocks everywhere.

In the later Precambrian an orogenic welt, called the "Carolinides," raised along the geosynclinal tract. In NE. Greenland a broad folded strip is traceable over a distance of 800 km. The author presumes that its westerly extension reappears in N. Ellesmere Island.

The Carolinidian chain, in the progress of denudation, acted as a long-enduring positive area, which had its essential influence on the depositional environments in NE. and central E. Greenland during the latest Precambrian and the lower Paleozoic.--Auth.

3-4005. Martin, L. John. TECTONIC FRAMEWORK OF NORTHERN CANADA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 442-457, 15 figs., Toronto, University of Toronto Press, 1961) 75 refs.

The record of a long and complex geologic history is preserved in the rocks of northern Canada. All geologic systems are represented and the rocks of most reach geosynclinal thickness within some part of the region.

The tectonic framework of northern Canada has been dominated by the North American continental craton and by geosynclines around its margins. The craton is bounded on the N. by the Franklinian geosyncline, which, as redefined by the writer, extends entirely across northern North America. In northern Yukon Territory it merges with the Cordilleran geosyncline, which bounds the craton on the W.

Evidence for Precambrian, Caledonian, Hercynian, Laramide, and possibly Nevadan orogenic movements has been observed. Periods of orogeny and of regional uplift have been separated, and in part overlapped, by periods of basinal and shelf sedimentation.

Maps and other figures showing the location and nature of basins, regional arches, and orogenic belts are presented. These are used to illustrate the tectonic pattern and its variation through time.--Auth.

3-4006. Thorsteinsson, R., and E.T. Tozer. STRUCTURAL HISTORY OF THE CANADIAN ARCTIC ARCHIPELAGO SINCE PRECAMBRIAN TIME (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 339-360, 4 figs. (2 under separate cover), Toronto, University of Toronto Press, 1961) 50 refs.

Two periods of Paleozoic tectonism have been detected in the Arctic Archipelago. The first, in late Silurian or early Devonian time produced N.-trending structures on Cornwallis and eastern Bathurst islands and probably also Grinnell Peninsula. Movements along the Boothia arch also took place at this time and produced northerly structures and contemporary fanglomerates on Somerset and Prince of Wales islands.

The second period resulted in the formation of the Parry Island fold belt, extending easterly from Melville Island, through Bathurst to Grinnell Peninsula, whence it extends northeasterly to a belt passing through Ellesmere Island. Across these belts, folding becomes more intense to the N. in the Parry Islands and to the W. on Ellesmere. The outer part of this arcuate fold system, adjacent to the Precambrian Shield craton, may be described as miogeosynclinal; the inner part, exposed only on northern Ellesmere and the N. tip of Axel Heiberg Island, is apparently eugeosynclinal. Study of the eugeosynclinal belt is difficult owing to extensive unconformable cover of Pennsylvanian and later rocks. From Melville Island to southern Ellesmere the folding involves a conformable Ordovician-Upper Devonian section; to the NE. youngest recognized rocks in the fold belt are Silurian. The folded rocks are overlain unconformably by marine Middle Pennsylvanian strata. Thus the main Paleozoic orogeny of the Arctic Islands is post-Upper Devonian, pre-Middle Pennsylvanian and essentially of Variscan age. Thick Devonian clastics, probably derived from the N. occur in the miogeosyncline of the Parry Islands and southern Ellesmere. Possibly an early Paleozoic mountain range shed this clastic material, but the remains of such a range have not been recognized. The solution to this problem might be elucidated by accurate dating of intrusives, volcanics, and metasediments on northern Ellesmere Island. The Devonian rocks of Prince Patrick and Banks islands are relatively undisturbed. Thus the Parry Island fold belt ends near western Melville Island and is evidently unrelated to mainland structures.

Tertiary (probably early Tertiary) folding and thrusting has produced northerly to northeasterly trending structures on Ellesmere and Axel Heiberg islands, and in places these latter structures are superimposed on the older, Paleozoic folds. Some blocks within the Tertiary fold belt (e.g. Lake Hazen plateau) were unaffected by these Tertiary movements. The Ringnes and northwestern Queen Elizabeth islands form a synclinorium, with transverse Tertiary folds. The axis of the synclinorium is marked by diapiric intrusions of Permo-Carboniferous evaporites. This axis extends northeasterly from northern Sabine Peninsula to the Ringnes Islands. N. to northwesterly trending folds intersect this axis. From the Ringnes Islands the belt of diapirs extends across the Tertiary fold belt of Axel Heiberg Island and ends near the mouth of Greely Fiord, Ellesmere Island. The axis of the synclinorium, and the belt of diapirs, mark the site of heavy sedimentation from Pennsylvanian to Tertiary, and the synclinal limbs (e.g. Borden Island, Mackenzie King Island, northwestern Melville Island, southern Sabine Peninsula, islands in Belcher Channel) have thin sections composed of rocks representing only

part of this time interval. Formations that extend from the limbs to the axis thicken by a factor of from 5 to 10 towards the axis. This basin of Pennsylvanian-Tertiary sediments (Sverdrup basin), like the Parry Island fold belt, is evidently unrelated to mainland structural features.

Normal faults, probably later than the Tertiary structures described above, are widespread in the Queen Elizabeth Islands. Judging from exposures, the islands S. of Parry Sound appear to have been tectonically quiet since Precambrian time, except for the movements adjacent to Boothia arch and minor faults on Banks and Stefansson islands. However it is probable that relatively recent faulting has contributed to the formation of the sounds and straits that characterize the archipelago today.--Auth.

3-4007. McNair, A.H. RELATIONS OF THE PARRY ISLANDS FOLD BELT AND THE CORNWALLIS FOLDS, EASTERN BATHURST ISLAND, CANADIAN ARCHIPELAGO (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 421-426, 2 figs., Toronto, University of Toronto Press, 1961) 7 refs.

Two sets of regional structures meet on eastern Bathurst Island. The older, N.-trending Cornwallis folds are characterized by vertical movement and appear to be of cratonic origin. These range from narrow, steep-flanked anticlines to broad synclines and anticlines. Conglomerates and 2 unconformities indicate that the Cornwallis folds had an initial, intermittent development extending from Middle Silurian to the Middle Devonian. During short times of stability in the Silurian, many small reefs grew along the margins of some anticlines.

The E.-W. Parry Islands miogeosynclinal fold belt consists of long parallel folds which decrease in amplitude eastward towards the Cornwallis folds. However, at several places the Cornwallis structures are relatively highly deformed by the E.-W. folds. The Parry Islands belt was deformed in the latest Devonian or during the Mississippian.

The final phase of deformation produced persistent N.-S. post-orogenic faults. In the southeastern part of Bathurst Island the faults controlled the emplacement of small sills, dikes, and laccoliths(?) of olivine basalt.--Auth.

3-4008. Jeletsky, J.A. EASTERN SLOPE, RICHARDSON MOUNTAINS: CRETACEOUS AND TERTIARY STRUCTURAL HISTORY AND REGIONAL SIGNIFICANCE (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 532-583, 24 figs., Toronto, University of Toronto Press, 1961) 31 refs.

Mid-Valanginian, late Aptian, early Albian, and late Albian and/or early Cenomanian orogenic phases have affected the area. Most of these phases correspond to well-known orogenic phases described elsewhere and have broadly regional or circumboreal range. Late Aptian movements created a 5° to 10° angular discordance. Other phases are recognizable only because of smaller or larger transgressive overlaps and disconformities. Short-lived major, northeasterly trending anticlinal structures (Aklavik arch and Dave Lord Creek arch) were, however, caused by the mid-Valanginian and again by late Albian and/or Cenomanian tectonic movements. These phases were, therefore, also mildly orogenic in nature.

The older Cretaceous orogenic phases, including the late Albian and/or early Cenomanian phase, did not end the subsidence of the Richardson Mountains trough. Subsidence and marine deposition persisted in the trough at least under Coniacian, and probably until late Campanian time.

The Upper Cretaceous rocks of the area are constantly involved in major dislocations. The contemporary structures of the area were, therefore, caused largely by the post-mid-Upper Cretaceous (?Tertiary) orogenic movements. These Alpine (= Laramide) movements have not only folded and faulted the rocks of the area but also closed and epeirogenically elevated the whole subsiding trough of the Richardsons; they represent, therefore, the principal post-Paleozoic orogenic period of that area.

The eastern slope of Richardson Mountains is dominated by fault block tectonics. Largest faults trend northerly, northwesterly, and northeasterly and split the area into a number of irregularly shaped and structurally disconnected fault blocks, which differ strongly in the degree of structural complexity and age of exposed rocks.

Strike-slip faults strongly predominate and form a single, conjugate system analogous to that of California. High-angle thrusts are only a minor complicating feature. The Donna River fault zone appears to be the master fault of the conjugate strike-slip fault system of the area. Most, if not all, of other strike-slip faults and thrusts of the area appear to be second-order faults of the Donna River fault zone. Allegedly normal faults occurring in places are probably not syngenetic with strike-slip faults and thrusts but older.

Folds of the area are medium- to small-sized and commonly domelike. Larger gentle folds trend northerly in the interior parts of larger fault blocks but are strongly disrupted by faults elsewhere; they were caused by an earlier orogenic phase that was generated by compressive stresses from the W. Smaller folds are mostly drag-folds subordinated to and caused by major faults, particularly by strike-slip faults. Both these drag-folds and the major faults of the area were caused by a later orogenic phase (or phases?) that was generated by compressive stresses from SW.

At least 2 piercement structures with gypsum and (?)anhydrite cores occur within the area on lower Donna River; they were probably triggered off by Alpine orogenic movements and are related to the Donna River fault zone.

The structure of the area contrasts strongly with that of the stable belt of the lower Peel and lower Mackenzie rivers situated E. of it. The latter belt is dominated by submeridionally trending "box anticlines" of post-mid-Upper Cretaceous age. These "box anticlines" appear to be a reflection of the basement faults rather than a result of the compressive stresses transmitted from the tectonically active belt of the Richardsons.

The structure of the area differs also from that of the central parts of the Richardson Mountains, which are dominated by symmetrical, large, mostly open folds, rather than by major faults. The eastern slope appears, thus, to form a separate structural zone of its own – the Richardson Mountains foreland – which separates the central part of the Richardsons from the stable belt of the Mackenzie lowlands.

The prevailing northerly trend of the Alpine structures of the area contrasts with the northeasterly trend of its mid-Valanginian and late Albian and/or early Cenomanian structures. This pattern of cross-folding was apparently caused by a change in stress direction between the Cenomanian and the Tertiary.

The northwesterly to submeridional structural trends of the British and Old Crow Mountains are pre-Carboniferous (Caledonian?) in age and unrelated to any of the Cretaceous and Tertiary structural trends

of the Richardsons. These geosynclinal (Brooks Range geosyncline) structures die out beneath the younger intracratonic structures of the northern Richardsons.

The Cretaceous and Tertiary structures of eastern Richardsons are basement controlled. The break-up of the basement into fault blocks apparently took place some time between early Precambrian and Tertiary time, possibly in the late Precambrian. The Alpine strike-slip faults of the area are therefore reactivated basement faults projected into the sedimentary cover by the later Alpine phase; they may be reactivated late Precambrian strike-slip faults.

Basement control and fault block tectonics are not restricted to the eastern Richardson Mountains but affect an extensive region within the eastern Canadian cordillera that includes the Alberta shelf, Mackenzie and Franklin mountains, the Richardsons, Porcupine and Eagle plains, central Alaska (Yukon stable block), British and Old Crow mountains, and the Mackenzie lowlands. This structural province, the western shelf of the Canadian Shield, is characterized by the Saxonian tectonics or paratectonics and so forms the marginal part of the western sedimentary basin rather than the marginal part of the Cordilleran geosyncline.

In contrast, the Canadian Rocky Mountains, Selwyn Mountains, Wernecke Mountains, and the Ogilvie Mountains are characterized by alpino-type deformation and lack of basement control. This orthotectonic structural province forms the marginal part of the Cordilleran geosyncline. W. of the Yukon-Alaska boundary this orthotectonic province merges into the geosynclinal belt of the Alaska Range S. of the Yukon stable block.

It is obvious that the physiographical uniformity of the eastern Canadian cordillera is unrelated to the bedrock structures and conceals at least 2 fundamentally different structural provinces.--Auth.

3-4009. Foose, Richard M., and others. STRUCTURAL GEOLOGY OF THE BEARTOOTH MOUNTAINS, MONTANA AND WYOMING: Geol. Soc. America, Bull., v. 72, no. 8, p. 1143-1172, 8 figs., 3 pls. incl. col. geol. map, scale 1:126,720, table, Aug. 1961, 108 refs.

The Beartooth Mountains - an 80 by 40 mi. elevated crustal block of Precambrian crystalline rocks - are in the Middle Rocky Mountains E. of the great N.-S. belt of overthrusts. The Beartooth Mountains are bounded on the E. by the Bighorn Basin (average structural relief, 15,000 ft.); on the NE. and N. by the Nye-Bowler lineament (along which movement has been dominantly left-lateral); and on the N. by the Crazy Mountain syncline (average structural relief of at least 10,000 ft.). The SW. side (Yellowstone-Absaroka Mountains) is mostly covered by thick Tertiary volcanic rocks.

Detailed mapping, supplemented by results of earlier workers, provides an integrated geologic picture of the tectonic development of the block. Much of the tectonic history is recorded in the structures developed in the Paleozoic and Mesozoic sedimentary rocks exposed around the edge of the mountains. The sedimentary rocks played a relatively passive role in the dynamic rise of the block during Laramide time, as they draped, folded, broke, and slid along the edge of the block.

A thrust plane(s) dipping WSW. is the major structural feature between the Clarks Fork of the Yellowstone and Nye, Montana. Near Red Lodge numerous tear faults displace the upper plate of the thrust as much as 10,000 ft. From Nye to Livingston, Montana, the major bounding structure is a NNE.-dipping thrust plane(s) terminating in several left-lateral tear faults. Near Gardiner a high-angle thrust plane dipping NE. bounds part of the SW. Beartooth.

Several structural mechanisms apparently operated during deformation: 1) Uplifting, tilting, and depressing of large crustal blocks. These commonly form ramps from the Beartooth massif to adjacent basins; during uplift smaller blocks were rotated in the opposite sense. 2) Vertical raising of the NW. and SE. corners. Here, the general lack of horizontal displacement relative to the adjacent basins limits the total horizontal displacement of the block. 3) Thrust faulting. Most of the frontal thrusts show moderate dips. Imbrication is developed particularly at the unconfined NE. corner. The major thrust steepens with structural depth to the S. The horizontal thrust displacement is not directly measurable at most places but is limited by the lack of horizontal movement at the 2 fixed corners of the block. 4) Tear faulting. Several major tear faults (displacements up to 10,000 ft.) bound large keystone-shaped blocks near Red Lodge. 5) Lateral shearing. During the late stage of uplift, horizontal movement toward the unconfined Red Lodge corner created major lateral shears, associated with imbrication, along the N. and E. sides, with folding along vertical axes and consequent shortening of the sedimentary section.

Tectonic development is attributed to 1) horizontal compressive forces, responsible for early crustal block movements and subcrustal plastic shifting, and 2) vertical forces of fluid pressures from the continued transfer of subcrustal material which probably helped raise the block. Uplift ceased when one or both of these forces terminated.--Auth.

3-4010. Harland, W. B. AN OUTLINE STRUCTURAL HISTORY OF SPITSBERGEN (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 68-132, 6 figs., 11 tables, Toronto, University of Toronto Press, 1961) 157 refs.

The history of earth movements in Spitsbergen is outlined in chronological order with special reference to the evidence of 1) sedimentology, 2) deformation structures, and 3) paleontological correlation. Some ideas on the structural position of Spitsbergen in relation to neighboring areas are reviewed with reference to the evidence by which they maybe tested. The references cited are designed to give a representative bibliography of modern sources leading to further critical detail and other references.--Auth.

3-4011. Atlasov, I. P., and V. N. Sokolov. MAIN FEATURES OF THE TECTONIC DEVELOPMENT OF THE CENTRAL SOVIET ARCTIC (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 5-17, 2 figs., table, Toronto, University of Toronto Press, 1961)

The structure of the central part of the Soviet Arctic is a result of prolonged tectonic development which took place in 7 main stages (tectonic periods). The structures formed comprised structural stages during each period respectively. The time limits of each stage were not entirely penecontemporaneous in adjacent regions.

The Archean geotectonic period was completed by a period of folding. A platform structure existed in the second half of the Proterozoic period in the central part of the central Siberian plateau while geosynclinal zones were situated in the rest of the

region. In the Sinian and especially in the lower-middle Paleozoic periods the platform which had originated in the Proterozoic spread progressively until it occupied nearly the whole area to the E. of the Urals. The upper Paleozoic-lower Mesozoic tectonic period was marked by the development of the Taimyr and the Verkhoyansk geosynclines. In the Urals-Novaya Zemlya area the geosyncline existed till the end of the Paleozoic. The Meso-Cenozoic tectonic period (J-Tr.) was characterized by a new expansion of the platform at the expense of the Taimyr geosyncline, and in the Cenozoic the whole area represented a platform.

Thus, the main features of the tectonic development of the central Soviet Arctic are recurrent changes of the tectonic pattern and erosion processes at the end of each tectonic period and of each phase of its development.

In the modern structure of the region in question we distinguish: the Mesozoic Verkhoyansk-Chukotskaya folded area consisting of the late Mesozoic Verkhoyansk and the Mesozoic-Cenozoic Novosibirsk folded systems and composed of 6 structural stages; the early Mesozoic Taimyr-Novaya Zemlya folded area which has 6 or 7 structural stages; the late Paleozoic Urals-Novaya Zemlya folded area characterized by 5 structural stages; the late Cenozoic Lena-Yenisey trough with 2 structural stages; the northern part of the W.-Siberian Epi-Hercynian platform, which has 3 structural stages; and the northern part of the Precambrian E. Siberian platform, consisting of 6 structural stages.

Ore zones both in geosynclines and in the platform are closely related to the basement faults, which served as feeding channels for magmas and hydrothermal solutions.

On the platforms and in the Lena-Yenisey trough in certain periods of the tectonic development, conditions and structural features favorable for oil and gas formation were present.

Oil and gas shows have been established in the Sinian and the lower-middle Paleozoic structural stages on the Siberian platform, and in the upper Paleozoic-lower Mesozoic, and in the Mesozoic-Cenozoic structural stages in the Lena-Yenisey trough, and on the W. Siberian platform.--Auth.

3-4012. Novikova, A.S. THE ORIGIN OF THE KAZAN-SERGIYEVSK BASIN: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 25-38, map, table, pub. 1961, 22 refs.

When a sedimentary mantle began to cover the Russian platform, grabenlike structures began to develop. The study of the Pachelma, Kresttsy, Kazan-Sergievsk, and other basins shows that the development of tectonic forms of the sedimentary mantle of the platform began by the breaking up of the basin into large blocks, and the formation of grabenlike basins between them. In Middle Devonian time the grabenlike Riphean Pachelma basin developed into a broad synclise, and the Kresttsy and Kotlas Riphean basins were buried under the neighboring Moscow synclise.

The tectonic development of the Kazan-Sergievsk basin in Middle Devonian and early Frasnian times however, was different. It continued to develop along the lines of the Riphean basin by "chipping" of adjacent parts of the old massif and by subsidence of new areas. At the beginning of middle Frasnian coincident with the cessation of volcanic activity it lost its graben appearance.

Volcanic rocks of Riphean and Devonian age are present in the marginal areas of the Kazan-Sergievsk structure where it adjoins the basement. This basin is a rudimentary grabenlike form in which dislocations of the layers has a faultlike character but often with an imperceptible shift of the blocks. These movements did not disturb the flat-lying beds within the blocks which were not complicated by deformation. The basins of the central part of the Russian platform are essentially similar.

The Kazan-Sergievsk basin is asymmetric, a feature probably also characteristic of other grabenlike structures. The total thickness of the Riphean and Devonian sediments filling the basin is less than 1,000 m. Equivalent sediments in other ancient basins in the central part of the Russian platform have a comparable thickness.

The composition of the magmatic rocks in the grabenlike structure is comparatively uniform. The intrusives belong to the gabbro group, and the extrusives to their equivalent: diabase, dolerite, basalt, andesitic-basalt, and their pyroclastic analogues.

The ferruginous-chamositic ores, bauxitic and chamositic-ferruginous clays, and also the terrigenous-calcareous rocks, form an association closely associated spatially with the marginal parts of the basin. The tuffs and andesitic basalts are also closely related to this structure. These interrelations disappeared together with the disappearance of the grabenlike structure.--J. W. Skehan.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 3-3955; Geomorphology 3-3972; Structural Geology 3-4006, 3-4008, 3-4010, 3-4011; Paleontology 3-4057, 3-4069; Sedimentary Petrology 3-4195, 3-4197; Fuels 3-4268.

3-4013. Devlin, Frank J. LOCATION OF MEASURED STRATIGRAPHIC SECTIONS: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1405-1406, Aug. 1961.

Measured sections used in the preparation of facies and other regional maps are best located by section, township, and range. To examine the described section in the field, reference should be made to geographical landmarks, e.g., "measured along the E. bank of the N. fork of Ash Creek Canyon, 1 1/2 mi. E. of Johnson's Ranch." Adequate location of measured sections is essential for examination of the basic field data.--F. E. Kottlowski.

3-4014. Jodry, Richard L., and Donald E. Campau. SMALL PSEUDOCHITINOUS AND RESINOUS MICROFOSSILS: NEW TOOLS FOR THE SUBSURFACE GEOLOGIST: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1378-1391, 5 figs., 3 pls., Aug. 1961, 39 refs.

The study of the Chitinozoa (possibly an extinct order of marine protozoans) and Tasmanites (probably a family of fossil algae) is generally included in the field of palynology, along with the study of polospores. Work in the Williston basin and other areas containing Paleozoic carbonate rocks indicates that the Chitinozoa and Tasmanites make ideal tools for use by the subsurface geologist. Because of their

nearly indestructible nature, these fossils may be concentrated in and recovered from the insoluble residue from drill chips used in normal sample examination. They are well adapted for use as an aid in solving problems of correlation, zonation, and age dating. In the Williston basin the Chitinozoa and Tasmanites have been used as an aid in the reconstruction of the Ordovician surface section in the subdivision of this section, and in extending these subdivisions into the subsurface. These micro-microfossils have aided in the solution of structural problems, and offer possibilities as a tool for age dating of Paleozoic rocks over very wide areas.--Auth.

3-4015. Blackadar, Robert G., and James Allan Fraser. PRECAMBRIAN GEOLOGY OF ARCTIC CANADA: A SUMMARY ACCOUNT (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 361-379, fig., 2 tables, Toronto, University of Toronto Press, 1961) 32 refs.

This paper describes the available information concerning the Precambrian N. of latitude 60° including results of the mapping program of the Geological Survey of Canada in 1959. Where data are available the stratigraphy of Proterozoic-type areas is discussed in some detail.--Auth.

3-4016. Rabkin, M. I., and M. G. Ravich. THE PRECAMBRIAN OF THE SOVIET ARCTIC (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 18-30, 4 tables, Toronto, University of Toronto Press, 1961.

The Precambrian deposits are situated in areas with different structural features. The Archean formations are developed in the northern part of the Siberian platform (the Anabar massif) and on the Baltic shield (Kolsky peninsula); the Proterozoic deposits occur in areas folded in Paleozoic time (the Taimyr peninsula, the Severnaya Zemlya, the Polar Urals) and in Mesozoic time (Chukotsky peninsula, etc.).

The Anabar massif consists of different hypersthene-bearing gneisses and crystalline schists often migmatized, paragneisses, marbles, and quartzites. This assemblage is divided into 4 conformable series of the granulite and amphibolite facies. Intrusions are related to 2 tectonomagmatic cycles: 1) the Archean cycle with 4 phases, which is mostly represented by alaskitic granites, and 2) the lower Proterozoic cycle (anorthosites).

The Archean of the Kolsky peninsula is divided into the Belomorsk and the Kolsk series. Paragneisses are dominant in the Belomorsk formation; the Kolsk formation consists of various gneisses, including the varieties rich in alumina. The Proterozoic is divided into 5 series of sedimentary and volcanic origin. The Archean intrusions are represented by an earlier phase (basic and ultrabasic rocks, oligoclase gneissic granites) and by a later phase (drusites and microline gneissic granites). The Proterozoic igneous rocks involve ultrabasic and basic intrusions and microcline granites.

The Precambrian of Taimyr-Severnaya Zemlya area is divided into the lower and the upper Proterozoic. The lower is represented by a thick assemblage (7-8 km.) of plagiogneisses and crystalline schists partly magmatized and formed mostly at the expense of terrigenous deposits under conditions of the amphibolite facies. The upper Proterozoic assemblage (6-7 km. thick) consists of greenschists, phyllites, marbles, and metamorphosed sandstones which were formed partly of sediments and partly of basic lavas under the greenschist conditions. Metaphosed ophiolites and orthoamphibolites occur among the Precambrian assemblages. The Proterozoic granitic rocks are represented by 3 groups: the porphyroblastic ultrametamorphic granitic rocks, the 2-mica, and the granulated granitic rocks.

In the Polar Urals a Proterozoic succession with gneiss, schist, and amphibolite members has been distinguished. The first 2 members have a sedimentary origin; the third one has a volcanic origin.

On the Chukotsky peninsula there is an undivided gneiss assemblage, overlain unconformably by Lower Silurian limestones. The Precambrian age is determined by analogy with the Seward Peninsula (Alaska). Biotite plagiogneisses and crystalline schists of the amphibolite facies are dominant in this assemblage. In its basal part there are marbles; gneissic granites and related migmatites are widespread.

The regions above differ sharply in their character. However, they have much in common. Intensive erosion and sedimentation in extensive areas is typical of them. Even in the lower Archean there were extensive geosynclines and vast land spaces subjected to erosion.--Auth.

3-4017. Katz, H. R. LATE PRECAMBRIAN TO CAMBRIAN STRATIGRAPHY IN EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic ...: v. 1, p. 299-328, 7 figs., table, Toronto, University of Toronto Press, 1961) 35 refs.

An 11,000 m. thick succession of unmetamorphosed sedimentary rocks underlies fossiliferous Lower Cambrian in the Caledonian fold belt of E. Greenland. It is subdivided into the late Precambrian Eleonore Bay group and the Eocambrian Mörkebjerg formation; the basal member of the latter includes tillites which contain boulders and pebbles of the underlying formations. Based on the occurrence of these tillites, regional time-stratigraphic correlations is believed to be well warranted.

The Eleonore Bay group has been subdivided into 4 formations, each with a number of well-established members. The lower 2 formations are quartzose and compose three-quarters of the whole group; the upper 2 formations are of a carbonate-shale succession with numerous algal dolomites and dark bituminous limestones. Throughout the sequence of the group, a typical mixed-shelf association represents the depositional product of a miogeosyncline.

With the beginning of Eocambrian time, this geosyncline was reduced in size, and a marginal part of its deposits was exposed to erosion. However, the area here considered remained mainly sea-covered, and the tillite material evidently was deposited by floating ice. There is some evidence that the source was an emerging land area farther to the E., while simultaneously a eugeosynclinal trough developed towards the W. Volcanic activity is indicated for this time in E. Greenland as well as in the comparable Hecla Hoek succession of Spitsbergen.

Although the beginning of Eocambrian time is characterized by a cold climate, the higher members of the Mörkebjerg formation demonstrate a rather rapid amelioration. A regression with evidence of desiccation and evaporation is indicated towards the top of the Mörkebjerg formation, the upper limit of which appears to be a regional disconformity. The subsequent transgression of the Bastion formation, with a conspicuous blanket sand at its base, brought with it ollenellid trilobites.--Auth.

3-4018. Khomentovsky, V.V. STRUCTURAL FACIES ZONES OF THE LOWER CAMBRIAN AND RIPHEAN AT THE SOUTHEASTERN MARGINS OF THE SIBERIAN PLATFORM: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 39-45, map, pub. 1961, 26 refs.

The following is the sequence in the Lena and upper Aldan stages (starting with the oldest): Kameshkov, Bazaikh, Sanashtykgol, Solontsov, and Obruchev units. These were compared to the standard Lower Cambrian stratigraphy of the Siberian platform. Biostratigraphic study permittted a reliable correlation of the sections, and a new approach to the delineation of structural facies was worked out.

Lower Cambrian platform type deposits occur in the Yenisey and southern Sayan region. To the SW. these become notably thicker, are characterized by the presence of flyschlike deposits, are considerably deformed and penetrated by intrusives. This type of section is characteristic of the miogeosynclinal foredeep which bordered the Siberian platform on the SW. from the Yenisey range to lake Baikal. In the miogeosyncline as on the platform, the Cambrian is unconformably on the Riphean. Further SW. this facies is replaced by the eugeosynclinal type.

The E. Sayan anticlinorium was a tectonic barrier of lower Proterozoic rocks during the Lower Cambrian and formed the boundary between mio- and eugeosynclines.

A sharp change between carbonate and extrusive facies occurs in the Gornaya Shoriya and in southern Kuznetsk Alatav. These facies zones coincide with structural zones. The extrusive facies is of greater thickness than the carbonate and forms troughs and depressions. The extrusive-filled depressions are marked by compressive linear folding, oriented parallel to the strike of the depression. The carbonate facies regions are characterized by wide folds having fantastic shapes and changing orientations.

The metamorphic and crystalline series of Lower Cambrian deposits is traced from the Tomsk massif southward through the Gornaya Shoria to the Gornaya Altay. Another branch connecting with that of the latter passes along the axial part of the western Sayan (Dzhebash upwarp).

The zones of intensive metamorphism coincide with the central areas of the geosynclinal troughs. The metamorphic belts vary in width according to the breadth of the troughs.

The intensely metamorphosed belts are bordered and warped almost along their entire length by tectonic deformations representing deep fractures. Numerous ultrabasic intrusions are connected with these belts.

These tectonic phenomena are considered in the deep fracture category and are the chief genetic factor of the geosynclinal troughs having been in existence at least since the late Proterozoic.

The formation and development of such fractures determined the tectonic structure and consequent development of the whole region. During the Riphean, geosynclines were formed which were later filled with volcanics. During the Lena stage these trenches reached their greatest breadth. By the end of Lower Cambrian the distribution of facies had become highly diversified. The massifs had been shattered by a fault system associated with the deep fractures and became principal areas of sedimentation for the developing carbonate series. Parallel to this, extensive lava sheets flowed over increasingly larger areas up to Middle Cambrian when they almost completely covered the area.

The deep fractures of the Kuznetsk Alatav ceased to function as unstable high-penetrability metamorphic zones by Upper Cambrian. At the same time geosynclinal processes died down, while in western Sayan, a Caledonian structure, the deep-fracture system functioned well into Ordovician. This is evidence that the high-penetrability zones constitute independent structural elements, playing a highly important role in geosynclinal formation.--J. W. Skehan.

3-4019. Maher, John C., ed. STRATIGRAPHIC CROSS SECTION OF PALEOZOIC ROCKS, WEST TEXAS TO NORTHERN MONTANA: 18 p., map, 6 secs. (in pocket), Tulsa, Oklahoma, American Association of Petroleum Geologists, 1960, 20 refs.

In 1946 the A.A.P.G. Committee on Stratigraphic Correlations began the preparation of a series of interregional stratigraphic cross sections designed to document accepted ideas of stratigraphic equivalence, to point out regional differences in usage of nomenclature, and to resolve some of the existing discordances in inter-regional correlation. The first publication, Geologic Cross Section of Paleozoic Rocks, Central Mississippi to Northern Michigan, was completed in 1953. A second cross section, designed to outline Paleozoic correlations from W. Texas to northern Montana and presented herewith in completed form, was begun about 1949.

The 6 cross sections and texts composing this special publication were prepared by study groups of the West Texas Geological Society, the Lubbock Geological Society, the Panhandle Geological Society, the Rocky Mountain Association of Geologists, the Wyoming Geological Association, and the Billings Geological Society.

Each of the cross sections is accompanied by a brief explanatory text. The first section, southern W. Texas, runs approximately N.-S. from Terrell County to Gaines County. It crosses 4 major geological provinces: Val Verde basin, Ozona platform, Central Basin platform, and Midland basin.

The second section, northern W. Texas, illustrates stratigraphy from the northern portion of the Palo Duro basin in central Deaf Smith County, across the Matador archipelago in northern Hockley County, the northern portion of the Midland basin in Hockley, Yoakum, Terry, and Gaines counties, ending on the Central Basin platform in southern Gaines County. The top of the Permian is used as the datum plane.

The third cross section illustrates stratigraphy from the Keyes dome in northeastern Cimarron County, Oklahoma, across the E. flank and S.-central portion of the Dalhart basin, and the eastern flank of the Bravo dome, into the northwestern portion of the Palo Duro basin. These geological provinces include the western portions of the Oklahoma and Texas Panhandles in Cimarron County, Oklahoma, and in Dallam, Hartley, Oldham, and Deaf Smith counties, Texas. The top of Paleozoic rocks has been used as the datum plane.

The fourth section, through eastern Colorado, shows the stratigraphic relationship of Paleozoic rocks across the Denver basin, over the Las Animas arch, and into the Hugoton embayment of the anadarko basin. Top of the Paleozoic rocks, in this region the Permian, was selected as the datum plane.

The fifth section passes through eastern Wyoming, characterized by stable-shelf deposition during Paleozoic time. Most of the detrital material probably came from the stable continental interior on the NE. or from upwarps that appeared from time to time along the margins of the shelf. Most important of these

upwarps was the late Paleozoic uplift of the ancestral Rocky Mountains, which tended to change the pattern of deposition. Top of the Paleozoic (Permian) was used as the datum.

The sixth section, from N. to S. across Montana, uses the top of Paleozoic rocks, the pre-Jurassic unconformity, as the datum. The most prominent feature is the central Montana or Big Snowy trough. The rapid stratigraphic changes across this tectonic feature are evidence of differential movement during Paleozoic time. The area, at different times, served both as a seaway connecting the Cordilleran syncline to the W. with the Williston basin on the E., and as a N.-S. barrier between the Alberta shelf to the N. and the Wyoming shelf to the S. The occurrence of progressively younger beds southward at the subcrop beneath the Jurassic sediments reflects the southward tilting and truncation of the Paleozoic and Mesozoic beds during pre-Jurassic or lower Jurassic time.--A. C. Sangree.

3-4020. Markov, F. G., and B. V. Tkachenko. THE PALAEOZOIC OF THE SOVIET ARCTIC (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 31-47, Toronto, University of Toronto Press, 1961)

Paleozoic deposits compose the mantles of the Russian and the Siberian platforms and the adjacent Caledonian and Hercynian folded areas, and partly form the basement of the Mesozoic-Cenozoic structures of the NE. U.S.S.R.

The discussion on the lower contact of the Paleozoic rocks is not over as yet. The Sinian complex is not proved to belong to the Paleozoic. On the Taimyr and the northern margin of the central Siberian plateau Cambrian deposits rest unconformably on Sinian rocks, sharply separated from the latter by their mineral composition and by fossils.

Complete sections of Cambrian strata represented mostly by carbonate rocks are known in N.-central Siberia. These rocks may be divided into biostratigraphic zones. W. of this is a region of continental deposits and volcanic activity, while to the E. we have an area of calcareous continental deposits. The breakdown of these formations is limited to series. Sometimes the Cambrian rocks contain bitumen.

The same depositional environment persisted into the Ordovician, but in the Urals-Novaya Zemlya and the Grampian geosynclines there was an increase in magmatic activity. The Ordovician deposits can be divided into the European stages. For middle Siberia a separate system of stages has been worked out.

The Silurian deposits, represented predominantly by carbonate facies, are found on the continent E. of the Timan mountain range and also on the Novaya Zemlya, the Severnaya Zemlya, and the Novosibirsk islands. These strata may be divided into series and stages. Magmatic activity took place in the Polar Urals.

The Devonian beds were deposited under rapidly changing depositional conditions caused by the Caledonian orogeny. On the Kolsky peninsula only Upper Devonian continental formations have been revealed. E. of the Timan-Kanin range and on the large islands the deposits of 3 Devonian series subdivided into stages are developed. The marine carbonate-terrigenous strata have been changed by hydrochemical substances, sometimes with the accumulation of salts and bitumen. Magmatic activity took place everywhere.

The Carboniferous deposits are mostly represented by carbonate rocks of the Lower series which are developed on Novaya Zemlya, the Novosibirsk islands and on the continent E. of the White Sea. Tournaisean, Visean, and more rarely Namurian deposits are distinguished. Middle and upper Carboniferous deposits are predominantly continental deposits with poorly preserved fossils, a fact which makes them similar to the higher Permian beds. Magmatic activity took place on the Kolsky peninsula and on the Novaya Zemlya.

Permian deposits are widespread over the whole region extending from the White Sea up to the Bering Sea and on Novaya Zemlya. The thick continental strata are often coal-bearing and sometimes oil-bearing. The Lower and the Upper series and more rarely the stages are recognized. The division into formations is commonly used. During the Permian period the Pechora, Taimyr, and Tunguska coal-bearing basins were formed.

By the end of Paleozoic time the geosynclinal development of the Urals-Novosemelsk area was completed. The Hercynian orogeny can be seen on the Taimyr, the Verchoyansk mountain area, the Novosibirsk islands, and in more eastern areas. Magmatic activity was intense, especially in the northern part of central Siberia where a thick formation of volcanic rocks (trap rock complex) had appeared, the development of which was continued until the Mesozoic time.--Auth.

3-4021. Cowie, J. W. THE LOWER PALAEOZOIC GEOLOGY OF GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 160-169, map, table, Toronto, University of Toronto Press, 1961) 9 refs.

The locations of outcrops are noted and the main workers on the lower Paleozoic of Greenland are mentioned. The stratigraphic successions in the E., NE., and NW. are summarized, and age relationships are discussed with reference to fossil faunas and breaks in the sequences. New conclusions emerge from this examination, and the correlations between Greenland, North America, and Europe are tabulated. The contribution of the stratigraphy to dating of the orogenies is noted.--Auth.

3-4022. Patterson, J. R. ORDOVICIAN STRATIGRAPHY AND CORRELATIONS IN NORTH AMERICA: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1364-1377, 12 figs., Aug. 1961, 37 refs.

The continuity of Ordovician strata in any area of occurrence can be demonstrated through the recognition of regionally distinct, tectonically delineated stratigraphic units. The recognition of these units in their areas of occurrence provides a remarkably similar and in some places almost identical picture of Ordovician successions. It is concluded that these stratigraphic units may be correlated between various regions in the manner envisaged by d'Orbigny for stages. The terminology for inter-regional classfication is proposed and is shown in relation to the alternate terms of the British succession. In this scheme some modification of graptolite ranges is required, notably that of the Nemagraptus gracilis fauna.--Auth.

3-4023. Fuller, J. G. C. M. ORDOVICIAN AND CONTIGUOUS FORMATIONS IN NORTH DAKOTA, SOUTH DAKOTA, MONTANA, AND ADJOINING AREAS OF CANADA AND UNITED STATES: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1334-1363, 21 figs., table, Aug. 1961, 52 refs.

Ordovician deposits in this area, the Williston basin, comprise 2 lithologically contrasted groups of strata: up to 320 ft. of sandstones and shales called the Winnipeg group, overlain by up to 1,000 ft. of limestones and dolomites called the Bighorn group. Cambrian rocks (locally ranging up into the Beekmantown) unconformably underlie the Ordovician in the western part of the basin; depositionally they fringed the Cordilleran trough and consisted mainly of clastic deposits. Silurian rocks, largely dolomite, reach a maximum of 1,120 ft., and succeed the Ordovician conformably. Pre-Devonian erosion cut deeply into the lower Paleozoic pile.

Winnipeg deposits reveal the earliest Williston basin outline. Sedimentation began with a central sandstone (Burgen) and passed at the first of several basin enlargements into a shale with peripheral sandstones (Winnipeg shale and sandstone) which, due to the absence of Cambrian rocks on the eastern side, transgressed onto the shield. These sandstones are not, as formerly supposed, equivalent to the earlier (Burgen) sandstone.

At the base of the Bighorn group another sandy deposit (Lander-Hecla beds) recorded a further step in sedimentary expansion. After a comparatively small amount of accumulation a far-reaching transgression brought further Bighorn deposits into contact on the W. with the Cambrian. Carbonate sedimentation dominated the remaining half of the lower Paleozoic.

In its basin interior development of the Bighorn group consists of limestones, rhythmically deposited evaporitic rocks, and argillaceous beds, known (in upward order) as the Red River (Viola), Stony Mountain, and Stonewall (Sylvan-upper Maquoketa) formations. In the peripheral area (the western periphery only has survived) the Bighorn consists of dolomite but reveals by recurrent changes of composition and texture the influence of the sedimentary regime controlling the central deposits.

Age considerations, resting mainly on the objective principle that any stratum is of the same stratigraphical age throughout its extent, lead to the following conclusions. 1) Ordovician rocks in the Williston basin area are a remnant of a once continent-spanning sheet. 2) Everywhere they lie unconformably on Beekmantown or earlier rocks. 3) The Winnipeg group is correlative with the pre-Bromide part of the Simpson group of Oklahoma, though no equivalent of the basal Simpson (Joins) may exist in the Williston area. 4) Red River strata (including the Hecla-Lander beds) are correlative with the Viola and upper Simpson rocks of Oklahoma, and, transgressing beyond the Winnipeg perimeter, lie on Cambrian (the classical Caradocian transgression?). This unconformity extends from Alberta to Oklahoma, thus approaching continental scale. 5) Upper Ordovician rocks (Stony Mountain and Stonewall or upper Maquoketa-Sylvan formations) overlie the Red River-Viola with regional conformity, and manifestly represent all Cincinnati stages. 6) Silurian rocks (Interlake-Hunton) rest conformably on the Ordovician but are everywhere affected by post-Silurian-pre-Devonian (Caledonian) or later unconformities.--Auth.

3-4024. Rogers, Wiley S. MIDDLE ORDOVICIAN STRATIGRAPHY OF THE RED MOUNTAIN AREA, ALABAMA: Southeastern Geology, v. 2, no. 4, p. 217-249, 4 figs., pl., 3 tables, June 1961, 14 refs.

The Chickamauga "limestone" (Middle Ordovician) in Alabama may be divided into 4 units which correlate well with sections previously studied in adjacent states. Detailed stratigraphic and lithologic studies of the existing outcrops in the Red Mountain area have been made.

That section of predominantly Middle Ordovician strata in Alabama and southern Tennessee lying between the uppermost members of the Knox group and the base of the Red Mountain formation should be called the Chickamauga group rather than the Chickamauga "limestone." The group is composed of the lithostratigraphic units herein designated as Unit I, Unit II, Unit III, and Unit IV, in ascending order. Gross correlation of these units is suggested with units 1, 2, 3, and 4 as erected by John Rodgers in eastern Tennessee. Unit I is Chazy in age and is correlated with Five Oaks and Lenoir limestones of Virginia and Tennessee and the Lenoir limestone of Cahaba Valley, Alabama. Units II and III are Black River in age and correlate with the Stones River group of the central basin of Tennessee and the Little Oak limestone-Athens shale sequence of Cahaba Valley, Alabama. Unit IV correlates with the Hermitage formation of the central basin of Tennessee and with the Martinsburg shale of Tennessee and Virginia, and is of Trenton age.

In the area investigated, the Chickamauga group lies directly on representatives of the Knox group or is separated from these representatives by the Attalla chert conglomerate. In many areas, the basal strata of the Chickamauga group is a dense, fine-grained limestone. In others, progressively toward the northeastern extent of the area, the limestone is replaced by red to tan shale. In most areas, the lower contact is readily determinable.

The upper contact of the Chickamauga group is generally well marked by the presence of the Red Mountain formation. In general, in the area studied, from NE. to SW., the Red Mountain formation lies on progressively older sections of the Chickamauga group. This upper contact relationship is variously the result of thrust faulting and (or) erosion.

The Chickamauga group in Alabama lies within the Tennessee "basin" which includes an area from Gadsden, Alabama, to a point just N. of Staunton, Virginia; western extension of this "basin" includes the central basin portion of central Tennessee. A positive area (the Blount Mountains) existed in western North Carolina during a major portion of the epoch. The resulting clastic wedge, called Blount delta by others, i is recognized in Alabama. The incursion of the clastic wedge into the basin resulted in a gradual westward replacement of limestones by shales. Thus, the Chickamauga group, as exposed in Jones Valley and its northern extensions, is composed of 2 major lithofacies, a southwestern nonclastic facies and a northeastern clastic facies. Strata in Cahaba Valley, of lower Middle Ordovician age, are continuations of the northeastern clastic facies.--Auth.

3-4025. Butler, H. DEVONIAN DEPOSITS OF CENTRAL EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 188-196, table, Toronto, University of Toronto Press, 1961)

In central E. Greenland, continental Devonian rocks interstratified with volcanites overlie Caledonian-folded formations in an elongated N.-S. basin. The sequence of beds 7,000 to 8,000 m. thick which comprises the upper part of the Middle Devonian and the whole of the Upper Devonian, can be divided into 5 series in the northern part of its area of distribution. These series arose as a result of late Caledonian orogenic phases which activated the older Caledonian mountain structure and are separated from each other by marked angular unconformities and basal conglomerates.--Auth.

3-4026. Bassett, H. Gordon. DEVONIAN STRATIGRAPHY, CENTRAL MACKENZIE RIVER REGION, NORTHWEST TERRITORIES, CANADA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 481-498, 2 figs., table, Toronto, University of Toronto Press, 1961) 11 refs.

Literature concerning Devonian stratigraphy in the Norman Wells-Fort Good Hope area is reviewed briefly, and arguments are presented to show that serious miscorrelations have been made. The author recommends that use of the names "Ramparts" and "Beavertail" be discontinued, and proposes that the formation names Bear Rock, Hume, Hare Indian, Kee Scarp, Canol, and Imperial be adopted for an ascending sequence of Devonian stratigraphic units.--Auth.

3-4027. Sandberg, Charles A. WIDESPREAD BEARTOOTH BUTTE FORMATION OF EARLY DEVONIAN AGE IN MONTANA AND WYOMING AND ITS PALEOGEOGRAPHIC SIGNIFICANCE: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1301-1309, 2 illus., map, Aug. 1961, 23 refs.

The brackish- and fresh-water Beartooth Butte formation of Early Devonian age has been tentatively recognized at 20 outcrops and 2 wells in southern and central Montana andnorthern Wyoming. It is generally less than 10 ft. thick, but it ranges in short distances from zero to more than 150 ft. in thickness. The lithologic character of the formation is varied, but a basal limestone or dolomite conglomerate characterizes most occurrences. In southern Montana and northern Wyoming, the Beartooth Butte crops out as discontinuous estuarine and fluviatile channel-fill deposits, sinkhole fillings, and regoliths that overlie the Bighorn dolomite of Late Ordovician age and underlie the Jefferson formation of Late Devonian age. The discovery of fish remains of possible Early Devonian age in the top of supposedly Lower Ordovician strata of the Big Snowy Mountains in central Montana may extend the Beartooth Butte formation 100 mi. N. of the other deposits. The Beartooth Butte may also be present between the Maywood formation of Late Devonian age and the top of Upper Cambrian rocks at Logan, in southwestern Montana, and at Beaver Creek, in W.-central Montana. Some sinkhole and channel-fill deposits referable to the Beartooth Butte are found at the top of Silurian rocks in the Williston basin.

Correlations between the Beartooth Butte formation, the Water Canyon formation of northern Utah, the lower part of the type Maywood formation of western Montana, and the upper part of the Ghost River formation of W.-central Alberta are suggested. A belt of discontinuous deposits of Early Devonian and probable Early Devonian age is inferred to extend in an almost straight line from northern Utah 900 mi. NNW. to W.-central Alberta. Shallow-water, nearshore marine rocks are probably present in this belt W. of the Beartooth Butte outcrops, whereas Lower Devonian marine rocks are apparently absent E. of those outcrops. It is suggested, therefore, that the Early Devonian sea that produced estuarine conditions in some channel-fill deposits of the Beartooth Butte formation lay at the W. This sea probably occupied a geosynclinal trough in Washington and Oregon and advanced eastward across Montana and Wyoming, whereas earlier and later Paleozoic marine invasions came southwestward from the Williston basin.--Auth.

3-4028. MacDonald, William D. THE UPPER DEVONIAN KETTLE POINT FORMATION OF ONTARIO: Can. Mining & Metall. Bull., v. 53, no. 583, p. 844-847, 8 figs., Nov. 1960, 19 refs.

The Upper Devonian Kettle Point black shale of southern Ontario is poorly exposed. Structural maps prepared from the data of numerous wells show that the upper surface of the formation has low regular relief, and that the lower surface reflects domes in the Middle Devonian and also local subsidence of the Devonian rocks due to solution of salt in the Silurian Salina formation. The appearance of minor amounts of marcasite, pyrite, and calcite, in that order, as interpreted from the evidence of concretions from the type locality at Kettle Point, is thought to have been influenced by a rise in the pH within anaerobic sediments preceding compaction.--Auth.

3-4029. Conant, Louis C., and Vernon E. Swanson. CHATTANOOGA SHALE AND RELATED ROCKS OF CENTRAL TENNESSEE AND NEARBY AREAS: U.S. Geol. Survey, Prof. Paper 357, 91 p., 18 figs., 17 pls. (8 in pocket), 14 tables, 1961, 169 refs.

The Chattanooga shale of Late Devonian age lies unconformably on many formations ranging in age from Middle Ordovician to Middle Devonian. It is overlain by the Maury formation, chiefly of Kinderhook (Early Mississippian) age, which is overlain conformably by the Fort Payne chert and related rocks. The Chattanooga shale and Maury formation have a combined thickness of about 35 ft.; standard localities for each are designated in DeKalb and Williamson counties, Tennessee, respectively.

The following stratigraphic classification is adopted:

Maury formation
Chattanooga shale
- Gassaway member (upper, middle, and lower units; Bransford sandstone bed locally at base)
- Dowelltown member (upper and lower units; Center Hill bentonite bed in upper unit)
- Hardin sandstone member (limited to southwestern part of area).

The Chattanooga shale is part of a blanket of black shale that was deposited in a sea that covered a large part of North America in Late Devonian time; in Tennessee this sea covered most of the Nashville dome, but a few areas, as the Hohenwald platform, remained as islands. The organic-rich and pyritiferous mud that formed the shale probably accumulated very slowly under reducing conditions in water 100 ft. deep or less; some accumulated near shorelines in water only a few feet deep.

The oil yield of the Chattanooga shale is about 10 gallons per ton, and other potentially economic byproducts are phosphate, black pigment, sulfuric acid, U, and light-weight aggregate. In an area on the E. side of the Nashville basin and probably extending E. to the Sequatchie anticline, shale about 15 ft. thick contains about 0.006% U, equivalent to about 1,800 tons of metallic U per sq. mi.--V.E. Swanson.

3-4030. Desborough, George A. SEDIMENTATIONAL AND STRUCTURAL DATING OF RATTLESNAKE FERRY FAULT IN SOUTHWESTERN ILLINOIS: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1401-1405, 3 figs., Aug. 1961, 9 refs.

Both Pre-Pennsylvanian and post-Pennsylvanian faulting have been recognized along the N. side of the Rattlesnake Ferry fault in southwestern Illinois. Minor faults which displace Chester strata and are over-

lain by essentially flat Caseyville beds are considered to be of pre-Pennsylvanian age and give rise to locally angular unconformity between Mississippian and Pennsylvanian strata.

Regional transport direction of lower Pennsylvanian sediments in the Eastern Interior Basin, based on cross-bedding studies, was to the SW. On the N. side of the Rattlesnake Ferry fault the transport direction was to the SE., parallel to the strike of the fault, and suggesting that the S., upthrown side of fault acted as a locally prominent barrier.--F. E. Kottlowski.

3-4031. Shotts, Reynold Q. CORRELATIONS IN THE "COAL MEASURES" OF THE SOUTHEAST: Alabama Acad. Sci., Jour., v. 31, no. 6, p. 427-446, 3 figs., Oct. 1960, 27 refs.

The Alabama coal fields, Pennsylvanian, are the most nearly isolated portions of the Appalachian coal field and have been studied least in relation to that entire region. Previous studies are reviewed. Difficulties and inconsistencies are pointed out and tentative suggestions for some broad correlations are made; fundamental to these, the Mary Lee coal beds of Alabama are correlative with the Sewanee coals of Tennessee. The principal purpose of the paper is to point out problems and possible lines of study which might lead to a systematization of the varying area-unit, lithologic-unit, and age-unit terminology.--M. Russell.

3-4032. Simms, Frederick E., Jr. PALEOTOPOGRAPHIC [SIC] CONTROL ON SEDIMENTATION AND ANALYSES OF JOINT PATTERNS WITH EMPHASIS ON CLEAT OF THE CONEMAUGH AND MONONGAHELA FORMATIONS NEAR MORGANTOWN, WEST VIRGINIA: West Virginia Acad. Sci., Proc., v. 31/32, p. 180-183, 1959-1960, 4 refs.

From a paleogeographic reconstruction of the Pittsburgh-coal roof rock in the Morgantown N., West Virginia-Pennsylvania, 7 1/2 min. quadrangle, it is concluded that after deposition of the Pittsburgh coal, a slight highland arose, a forerunner of the Fayette anticline. This inhibited the streams which deposited the channel sands E. of the anticline. The sands were washed around the NE. end of the barrier to be deposited in Dunkard township, Pennsylvania. Contemporaneously fresh-water limestone and shale were deposited in a quiet lake W. of the barrier. Cleats in the Conemaugh and Monongahela coals in the area are due to tectonic forces.--M. Russell.

3-4033. Butler, H. CONTINENTAL CARBONIFEROUS AND LOWER PERMIAN IN CENTRAL EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic. . .: v. 1, p. 205-213, map, Toronto, University of Toronto Press, 1961)

In central E. Greenland the upper Carboniferous and Lower Permian sediments are replaced by predominantly coarse-clastic continental deposits of a total thickness of more than 5,000 m. They occupy a narrow stretch of land near the outer coast between 71°15' and 74°20' N. This paper attempts, on the basis of the still incomplete investigations, to summarize the most important results of the distribution, lithological characteristics, position, and stratigraphy of these rocks.--Auth.

3-4034. Bissell, Harold J. EASTERN GREAT BASIN PERMO-PENNSYLVANIAN STRATA - ADDITIONAL STATEMENT: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1410-1411, Aug. 1961, 17 refs.

Since publication of the preliminary statement and figures relating to Pennsylvanian and Permian strata in the eastern Great Basin, the writer has received queries concerning lack of references. This material was included in the original, longer manuscript submitted to the American Association of Petroleum Geologists in 1956 for the Pennsylvanian Symposium Volume. Brief mention in this note indicates some of the pertinent sources of information; a list of selected references is appended. All nomenclatural, geographic, and paleogeographic names are extant as published information or are suggested as new by the writer.--F. E. Kottlowski.

3-4035. Maync, Wolf. THE PERMIAN OF GREENLAND (In: Raasch, Gilbert O., ed. The Geology of the Arctic. . .: v. 1, p. 214-223, chart, Toronto, University of Toronto Press, 1961) 52 refs.

Marine deposits of late Permian age are widely distributed along the coast of E. Greenland. Their contact with the underlying older Paleozoic or Caledonian basement is an angular unconformity, and the series reveals a complex facies pattern. Eight different lithofacies members have been distinguished. As all these lithic units are intimately interlinked, they obviously represent contemporaneous deposits laid down under different ecological conditions. The rich faunas prove that this variegated series, previously referred to as upper Carboniferous, subsequently as Lower Permian, is of Upper Permian (Zechstein) age.

In N. Greenland, marine fusulinid-bearing beds of late Carboniferous-early Permian age are known to occur, and in the area between 72° and about 70° N. there occur continental beds carrying plants and paleoniscid fish remains which are tentatively dated as uppermost Carboniferous or Lower Permian.--Auth.

3-4036. Hills, John M. CORRELATION OF PERMIAN FORMATIONS OF NORTH AMERICA: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1412-1414, Aug. 1961, 18 refs.

Discussion of GeoScience Abstracts 3-1133. The equivalence of the San Andres dolomite of the Central Basin platform and shelf areas with the Blaine and Dog Creek of the Panhandle, southeastern Colorado, and Kansas seems certain. Perrinites occurs in the lower part of the upper San Andres. In the Permian basin, beds which can be traced (in the subsurface) into typical San Andres dolomite contain fusulinids which apparently are Guadalupian in age.

The chart shows the Abo as essentially confined to the Wolfcamp. R. E. King and Lloyd correlated the red and green shales of the lower Leonard in (SE.) New Mexico with the type Abo, although admitting that these shales might extend down into the Wolfcamp. The subsurface correlation (based on widely scattered oil tests) seems obvious as far westward as the eastern flank of the Pedernal uplift. From here (N.-) W. to the type locality in Abo Canyon, the correlation is uncertain.--F. E. Kottlowski.

3-4037. Bryant, Donald L., and Neal E. McClymonds. PERMIAN CONCHA LIMESTONE AND RAINVALLEY FORMATION, SOUTHEASTERN ARIZONA: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1324-1333, 3 figs., Aug. 1961, 14 refs.

The Concha limestone of Gilluly and others, and the Rainvalley formation, herein defined, are the youngest strata of Permian age recognized in southern Arizona. The 2 formations occur in many of the outcrops of upper Paleozoic rocks in southeastern Arizona, but have not been identified W. of central Pima County, Arizona. The type section of the Concha limestone in the Gunnison Hills, Cochise County, Arizona, is incomplete, and a reference section is proposed from the Mustang Mountains. The Concha limestone is thick-bedded to massive, gray to dark gray, and very finely crystalline, and it contains numerous chert nodules, particularly in the lower 180 ft. It is 570 ft. thick at the reference locality. The Rainvalley formation conformably overlies the Concha limestone and is 390 ft. thick at the proposed type locality in the Mustang Mountains. It is made up of thin-bedded limestone and dolomitic limestone units and a few sandstone beds. The Rainvalley is separated from the Concha limestone because its beds are thinner and more varicolored and have a higher dolomite content than the thick-bedded limestone of the Concha.

The age of the Concha is tentatively considered Leonard and Guadalupe(?) and that of the Rainvalley, Guadalupe(?).--Auth.

3-4038. Sachs, V. N., and S. A. Strelkov. MESOZOIC AND CENOZOIC OF THE SOVIET ARCTIC (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 48-67, 11 maps, 4 tables, Toronto, University of Toronto Press, 1961)

On the Soviet Arctic territory Mesozoic and Quaternary deposits are widely developed; Neogene and Paleogene deposits are met only sporadically. Marine facies of Triassic deposits are known E. of the Hatanga meridian and on Fraz Josephs land, all the stages being distinguished, including the conventional Rhaetian.

The Lower Triassic is divided into 2 stages: the Indus and the Olenek. The continental and lagoonal Triassic facies are widespread in the northern part of the Russian plain, on Franz Josephs land, and in the northern part of middle Siberia. The last area is notable for an important role of volcanic rocks in the Lower Triassic. The Jurassic predominantly marine deposits are divided into series, stages, and, partly, into substages. The basal stages of the Lower Jurassic are revealed in NE. Siberia.

Since the Domerian the marine facies expanded towards the northern part of central Siberia and since the Aalenian towards Franz Josephs land. During the upper part of the Middle Jurassic and lower part of Upper Jurassic the marine facies expanded towards the northern part of W. Siberia and the Russian plain.

The lower horizons of Cretaceous strata are also widespread, but since the Hauterivian the development of marine facies has been considerably reduced, and continental and lagoonal formations begin to predominate. The marine sediments of the upper half of the Lower Cretaceous and Upper Cretaceous strata have remained in the northern part of W. Siberia and along the coast of the Bering Sea. The Cretaceous deposits in NE. Siberia also involve large intrusions and lava effusions.

Paleogene and lower degree Neogene deposits occur in the northern part of W. Siberia, along the Bering Sea coast, and locally in NE. Siberia.

Lower Quaternary deposits distinguished by the remnants of preglacial mountain-coniferous flora and by mammalian fauna, are known in NE. Siberia. The probable moraine of the first glaciation (Mindel? Kansan?) is almost completely eroded.

The higher beds are represented by intraglacial sediments (marine and continental) and deposits of the most extensive glaciation (Riss, Dneprovian, Illinoian)with several stages (the Smarovo and Taz being probably analogous to the Illinoian and Iowan).

Then follow the sediments of boreal (Eem) transgression which are developed W. of Anabar and on Chukotsky peninsula. On the surface they are almost everywhere overlain by deposits of the last (Zyrianka) glaciation correlated with the Wisconsin (all phases included). The NE. Siberian plains are underlain by late and postglacial lake-alluvial deposits.--Auth.

3-4039. Tozer, E.T. SUMMARY ACCOUNT OF MESOZOIC AND TERTIARY STRATIGRAPHY, CANADIAN ARCTIC ARCHIPELAGO (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 381-402, 6 figs., Toronto, University of Toronto Press, 1961) 49 refs.

The Mesozoic and Tertiary rocks of the Canadian Arctic Archipelago are mainly preserved in the Queen Elizabeth Islands, N. of Parry Sound, and on Banks Island. Small patches of nonmarine beds, of uncertain age, occur on Baffin Island.

The Mesozoic-Tertiary rocks of the Queen Elizabeth Islands are best developed in the Sverdrup basin, a sedimentary basin centered on Axel Heiberg and the Ringnes islands, containing an essentially conformable Pennsylvanian to early Tertiary sequence. On the margins of the basin, which are S., E., and SW. of the central, axial part, many formations show transgressive overstep and sections are incomplete compared with those of the axis.

Marine and nonmarine formations alternate. Marine formations are gray shale on the axis of the basin; quartz sand, in part glauconitic, on the margins. Nonmarine formations are quartz sand, sandstone, and shale, commonly with coal, essentially similar in facies (but not thickness) on both the axis and the margins. Closely similar facies recur at several levels, and the geographic position of the marine sand-shale facies boundary is commonly the same for deposits of different ages.

Marine faunas of the following ages have been identified. The names of the formations in which these faunas occur are given in parentheses. In the following list the sandstone formations that characterize the margins of the basin are followed by (S); the Blind Fiord, Blaa Mountain, Savik, Deer Bay, Christopher, and Kanguk formations are mainly shale and siltstone.

Triassic (identified by the writer); Scythian (Blind Fiord); Anisian, Ladinian, Karnian (Schei Point (S), Blaa Mountain); Norian (marine band in mainly nonmarine Heiberg).

Jurassic (identified by H. Frebold); Sinemurian (unnamed beds on Borden and Melville islands (S); Toarcian and lower Bajocian (lower Wilkie Point (S), Jaeger (S) Savik); Bathonian (lower Wilkie Point (S); Callovian (Jaeger (S), Savik); Oxfordian (Savik?); Oxfordian or lower Kimmeridgian (local marine bands in mainly nonmarine Awingak, local basal shale of Mould Bay); Portlandian s. l. (in part identified by J. A. Jeletzky) (Mould Bay (S), Deer Bay).

Cretaceous (identified by J. A. Jeletzky); Berriasian and Valanginian (Mould Bay (S), Deer Bay); Aptian? and Albian (Christopher); Santonian or early Campanian (Kanguk).

Several of these formations are time equivalents.

Blaa Mountain and Schei Point are equivalent. Lower Wilkie Point, Jaeger, and Savik are partly equivalent. Mould Bay and Deer Bay are equivalent. These equivalent formations interfinger in parts of the area, e.g. on Raanes Peninsula, Ellesmere Island for the Triassic, and on Borden and Mackenzie King islands for the Jurassic and lowermost Cretaceous.

Nonmarine formations alternate with the above-mentioned marine beds and represent the following time intervals (formation names are again given in parentheses). Late Triassic and possibly early Jurassic (Heiberg); late Jurassic (Awingak and upper Wilkie Point); Lower Cretaceous (Isachsen), and mid-Cretaceous (Hassel). On western Axel Heiberg Island the Strand Fiord basalt lies between the Hassel and Kanguk formations.

Tertiary beds are entirely nonmarine and mainly sandstone, shale, and coal (Eureka Sound formation). Plant fossils, according to Wayne Fry and C. D. MacGregor, are early Tertiary and perhaps also Cretaceous. Adjacent to some fault line scarps (e.g. Stolz Range of eastern Axel Heiberg) there are conglomerates derived mainly from the nearby gabbro sills that intrude the whole Mesozoic section beneath the Strand Fiord basalt. These conglomerates seem to be high in the Eureka Sound formation, and their appearance probably signals the start of the Tertiary earth movements that followed the long, essentially uninterrupted period of sedimentation within the Sverdrup basin. Except for the fluviatile and deltaic Beaufort formation of the Arctic Coastal Plain, which may be Pleistocene, there are no known post-orogenic Tertiary deposits in the Queen Elizabeth Islands.

Within the Sverdrup basin Triassic formations reach a thickness of 17,500 ft.; Jurassic 1,500; Cretaceous 12,000; Tertiary, about 10,000. Sections on the margins are much thinner, partly through omission of beds, mentioned above. Distribution of facies belts suggests southern and eastern source for most of sediments.--Auth.

3-4040. Trümpy, Rudolf. TRIASSIC OF EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 248-254, Toronto, University of Toronto Press, 1961) 22 refs.

In central E. Greenland, ammonite-bearing strata of lower Eotriassic age overlie the marine Permian formations conformably and without a gap. They are followed by poorly fossiliferous arkoses and redbeds representing the upper Eotriassic as well as the middle and upper Triassic. Marine upper Skythian and Anisian deposits are known from NE. Greenland.--Auth.

3-4041. Pelletier, Bernard R. TRIASSIC STRATIGRAPHY OF THE ROCKY MOUNTAINS AND FOOTHILLS, NORTHEASTERN BRITISH COLUMBIA: Canada, Geol. Survey, Paper 61-8, 32 p., map, 1961, 5 refs.

Triassic formations in northeastern British Columbia overlie Permian chert with disconformity and in turn are disconformably overlain by lower Cretaceous shales. Triassic of the eastern sections is present entirely between these boundaries and is less than 4,000 ft. thick. Westward, the system thickens then thins, although neither the overlying nor underlying contacts were observed. The recognizable formations converge to the E. and are from bottom to top respectively, Grayling, Toad, and Liard formations, and unnamed Upper Triassic beds. Ammonites and the pelecypod Claraia stachei indicate a marine environment for the shales and minor sandstones of the Grayling. Platy siltstones and shales alternate with massive siltstones in the Toad which reaches a maximum thickness of 3,000 ft. in the Racing River area. The Liard formation, present eastward from the Racing River area, comprises a shallow-water sandstone and massive siltstones. The unnamed post-Liard beds consist of limestone and sandstone with siltstones and limestones in the upper beds. Widespread primary sedimentary current structures suggest a probable source area to the NE. for all of the formations. Lateral and vertical migration of sedimentary facies suggests progressively southwesterly occurrences of similar depositional sites as the Triassic period advanced. The presence of oil and gas in sands interpreted as offshore bars or lenses follows a similar trend as these lenses are an integral part of the sedimentation system. Eight measured sections are presented in detail.--B. C. McDonald.

3-4042. Callomon, J. H. THE JURASSIC SYSTEM IN EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 258-268, 2 tables, Toronto, University of Toronto Press, 1961) 15 refs.

The Jurassic in E. Greenland is largely complete except for 2 breaks: one at the top of the Liassic extending into the Bajocian, and one between lower Callovian and upper Oxfordian. The faunas of the Liassic closely resemble those of northwestern Europe. In contrast those of the Middle Jurassic as represented in E. Greenland are peculiar to the Arctic and can be closely correlated with the European succession only at the top, which is lower Callovian. The Upper Jurassic starts in Oxfordian with faunas of NW. European type, is succeeded by higher ones of mixed NW. European and Volgian aspects, and finally passes with no considerable break into the Cretaceous. Such stratigraphic breaks as do occur are still in the Jurassic and therefore of no aid in defining the Jurassic-Cretaceous boundary.--Auth.

3-4043. Donovan, D. T. CRETACEOUS OF EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 274-277, table, Toronto, University of Toronto Press, 1961) 4 refs.

Sedimentation in the Greenland Cretaceous may have been continuous from the Upper Jurassic into the Berriasian and Valanginian stages, but the Hauterivian and Barremian are unrepresented. Aptian, Albian, and lower Cenomanian are all present in clastic marine facies, predominantly shaly. At least 3 horizons above the Cenomanian are recognized by fossils, but their stratigraphy is poorly known. The highest is of upper Campanian age.--Auth.

3-4044. Brown, Charles W. CENOZOIC STRATIGRAPHY AND STRUCTURAL GEOLOGY, NORTHEAST YELLOWSTONE NATIONAL PARK, WYOMING AND MONTANA: Geol. Soc. America, Bull., v. 72, no. 8, p. 1173-1193, 8 figs., 6 pls. incl. fold. geol. map, Aug. 1961, 39 refs.

Cenozoic eruptive rocks and terrestrial sediments were deposited on a structurally complex basement of Precambrian, Paleozoic, and Mesozoic rocks in the Yellowstone Park region. Eruption of lower Cenozoic andesitic breccias and tuffs appears to have been cyclic, for the pyroclastic rocks become more mafic up-section with an increase in the relative abundance of breccia beds and decrease in tuff units.

As each cycle proceeded, less silicic and more mafic material was ejected. The writer suggests that the cycles represent periodic tapping and drawing off of an upper, volatile-rich fraction of the source magma. A major hiatus separates the lower Cenozoic rocks from upper Cenozoic rhyolites and associated rocks in northern Yellowstone Park which are believed to be Pliocene and younger.

At least 5 phases of deformation can be recognized in the map area: 1) Precambrian metamorphism, 2) Lancian to early Eocene Laramide folding and faulting, 3) middle Eocene fracturing and normal faulting, 4) post-middle Eocene pre-late(?) Pliocene normal faulting, and 5) post-late(?) Pliocene normal faulting of rhyolitic welded tuffs.--Auth.

3-4045. Wenk, Eduard. TERTIARY OF GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic. . . :v. 1, p. 278-284, Toronto, University of Toronto Press, 1961) 33 refs.

Tertiary rocks of central E. Greenland are almost entirely igneous, and consist predominantly of basaltic extrusives and basic dikes. More locally gabbroic, syenitic, and granitic intrusions occur.

Extrusion was primarily subaerial, and scoriaceous and agglomeratic material is associated. Arkoses and graywackes are intercalated in the lower part of the flow sequence, where coaly leaf and wood material is locally abundant. Erosion appears to have alternated with extrusion. Fissure eruption is postulated by most authorities. Sills are prominent in local areas.

Floras of the intercalated sediments are interpreted as Paleocene or oldest Eocene by Mathiesen. The much scarcer marine faunas have been more variously interpreted as to age. According to present knowledge the earliest flows are Senonian (or just post-Senonian) and the latest late Eocene or Oligocene.

The Tertiary terrane of central E. Greenland is part of the Brito-Arctic province, and is in causal relation with the separation of geologically related blocks of Greenland, Spitsbergen, and Scotland.--Auth.

3-4046. Keefer, William R. WALTMAN SHALE AND SHOTGUN MEMBERS OF FORT UNION FORMATION (PALEOCENE) IN WIND RIVER BASIN, WYOMING: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1310-1323, 5 figs., Aug. 1961, 13 refs.

The Fort Union formation of Paleocene age in the Wind River Basin of central Wyoming consists of interbedded sandstone, conglomerate, and carbonaceous shale of fluviatile origin overlain by fine-grained clastic strata of lacustrine or marine origin. The latter sequence consists of 2 units, one deposited in the marginal areas surrounding the Paleocene lake or sea during the period of maximum expansion and subsequent regression, and the other deposited in the offshore areas.

Strata representing the marginal unit are named the Shotgun member from exposures near Shotgun Butte in the N.-central part of the Wind River Basin. The member is 2,830 ft. thick at the type section and characterized by uniformly bedded soft claystone, siltstone, and shale with minor amounts of sandstone and carbonaceous shale. Typical colors are gray, olive-drab, buff, brown, and tan, but some zones are pale red and purple. Vertebrate fossils indicate a middle and (or) late Paleocene age, except for the uppermost part which possibly is earliest Eocene in age. The fossils include remains of marine-type sharks.

Strata representing the offshore unit are named the Waltman shale member from exposures near Waltman in the eastern part of the Wind River Basin. The type section consists of 645 ft. of chocolate-brown and gray silty micaceous claystone interbedded with a few thin beds of ledge-forming sandstone. In subsurface sections the member is a remarkably homogeneous dark brown to black silty micaceous shale and covers a region of several hundred square miles. The maximum thickness is about 2,600 ft. The shale is commonly glauconitic and pyritic, and contains appreciable amounts of organic material, some of which converts to oil upon distillation. Preliminary spore and pollen studies indicate a middle and late Paleocene age.

Where thickest, the Shotgun and Waltman shale members are essentially contemporaneous units, and there is a nearly complete lateral gradation between the 2 lithologic types. At many places, however, both members are present, and thin transitional zones of interbedded sandstone, black micaceous shale, carbonaceous shale, and coal directly underlie and overlie the Waltman shale member. The lower zone is a transgressive series and is included in the lower part of the Fort Union formation, and the upper zone is a regressive series and is included in the overlying Shotgun member. Many of the sandstone beds in the transition zones are glauconitic.

The marine-type sharks, specimens of hystrichosphaerids, and glauconite formed in place suggest a marine origin for the strata in the upper part of the Fort Union formation. Analytical data, however, suggest that deposition was in waters that were less saline than normal marine waters. It is tentatively concluded that these upper Fort Union strata originated in a restricted body of water that had limited access to the Cannonball sea which extended from the Gulf of Mexico to South and North Dakota during Paleocene time.

Intertonguing of the Waltman shale member with porous sandstone beds of the enclosing strata, and the organic content of the shale, provide favorable conditions for the generation, migration, and accumulation of oil and gas in the lower Tertiary rocks of the Wind River Basin.--Auth.

3-4047. Harksen, John C., and others. NEW MIOCENE FORMATION IN SOUTH DAKOTA: South Dakota, State Geol. Survey, Misc. Inv. no. 3, 11 p., 3 figs., 1961, 3 refs.

The Sharps formation, named for exposures near Sharps Corner in Shannon County, South Dakota, consists of 390 ft. of massive tan silt and volcanic ash. This distinctive new stratigraphic unit is present between the Brule formation of the Oligocene White River group below, and the Monroe Creek formation of the Miocene Arikaree group, above. The Sharps formation includes a basal volcanic ash bed, called the Rockyford ash. The ash consists of white, buff, tan, and reddish-brown layers with varying amounts of silt impurities, and is as much as 38 ft. thick. The ash is poorly consolidated but well compacted. A detailed description of the type section is included. --L.M. Dane.

3-4048. Eliseev, V.I. THE MOST IMPORTANT FEATURES OF QUATERNARY (ANTHROPOGENE) DEPOSITS IN THE NORTHEASTERN PERIPHERAL PART OF THE CHUYSK TROUGH: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p.

46-59, 3 figs., table, pub. 1961, 16 refs.

On the basis of determinations by a joint method (paleoclimatic, lithogenetic, tectonic, and biostratigraphic), the lower boundary of the Quaternary should be moved back to the base of the upper Pliocene Kenshagyr formation (or Eo-Pleistocene, according to Gromov's classification) in the Chuysk steppes; to the base of the Ili formation in adjacent regions of Kazakhstan; and to the base of the straw-colored formation in Tien-Shan.

The Quaternary of the Chuysk steppes (including Eo-Pleistocene Kenshagyr formation) is represented exclusively by continental sediments divisible into 5 groups or series. The structure of Quaternary alluvial formations in the Chuysk steppes confirms the Shantser classification as regards the relationship of the channel and floodplain facies in narrower parts of a valley. In the subsidence areas, on the other hand, the author has identified flood facies not correlated with his floodplain facies.

A study of alluvial formations in the Gulyaevka subsidence zone suggests that this area underwent 2 glaciations - a middle Pleistocene and an upper Pleistocene - when the climate became substantially cooler and more humid, and the ancestral Chu River became swollen.--J. W. Skehan.

3-4049. Wrucke, Chester T. PALEOZOIC AND CENOZOIC ROCKS IN THE ALPINE-NUTRIOSO AREA, APACHE COUNTY, ARIZONA: U. S. Geol. Survey, Bull. 1121-H, 26 p., 2 maps, 1961, 19 refs.

The Alpine-Nutrioso area, in E.-central Arizona, adjacent to New Mexico, contains limestone and shale of Pennsylvanian or Permian age and 4 Cenozoic formations consisting of sedimentary and volcanic rocks. The area is part of a geologically little-known mountain region that separates the Colorado Plateau from the Basin and Range province across most of Arizona.

The rocks of Pennsylvanian or Permian age form an exposed section about 40 ft. thick and tentatively are correlated with the Naco group of southern Arizona.

The oldest Cenozoic rocks comprise the Datil formation, subdivided into a lower or sedimentary member at least 680 ft. thick and an upper or andesite member 400 ft. thick. The Datil is Miocene(?) in age. Overlying the Datil are sandstones as much as 1,200 ft. thick referred to as the upper sedimentary formation. These sandstones, principally of eolian origin, are similar to the Chuska sandstone of northeastern Arizona and are possibly Pliocene in age. Basalt flows as much as 900 ft. thick of Tertiary or Quaternary age overly the upper sedimentary formation. The youngest formation is basalt of Quaternary(?) age.

The structure of the area is characterized by nearly horizontal strata and few faults. The position of the Naco(?), which crops out hundreds of feet higher than usual in the region, indicates that the pre-Cenozoic rocks are either structurally more complex than younger formations or that the Naco(?) occurs as xenoliths in Datil andesite. Most of the Cenozoic rocks have a gentle dip to the S.--Auth.

3-4050. Berthelsen, Asger. ON THE CHRONOLOGY OF THE PRECAMBRIAN OF WESTERN GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 329-338, fig., Toronto, University of Toronto Press, 1961) 17 refs.

Since E. Wegmann's classical investigations in southern Greenland, survey work has been concentrated in central W. Greenland (1946-1954) and SW. Greenland (1954-). The chronological data obtained within the 2 better studied regions are presented and discussed in the light of some recent absolute age determinations.--Auth.

3-4051. Tupper, William M., and S. R. Hart. MINIMUM AGE OF THE MIDDLE SILURIAN IN NEW BRUNSWICK BASED ON K-Ar METHOD: Geol. Soc. America, Bull., v. 72, no. 8, p. 1285-1287, map, 2 tables, Aug. 1961, 9 refs.

Five stratigraphically dated granitic bodies in New Brunswick have a K-Ar age between 380 and 400 m.y. Four of the granites are post-Middle Silurian and pre-Pennsylvanian in age. The fifth granite body is post-Middle Silurian and pre-Late Devonian. This indicates a minimum age of 380 m.y. for Middle Silurian time in New Brunswick.--Auth.

3-4052. Baadsgaard, H., and others. CALEDONIAN OR ACADIAN GRANITES OF THE NORTHERN YUKON TERRITORY (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 458-465, 4 figs., table, Toronto, University of Toronto Press, 1961) 18 refs.

Biotite from a granite on Mount Fitton, northern Yukon Territory, returns a K-Ar age of 353 million years. Evidence, mainly from the Appalachian area of eastern North America and the Caledonian orogenic belt of Europe, suggests that extensive orogeny and granite emplacement occurred about 350 million years ago, probably during the Devonian period. The implications of the presence of mid-Devonian granites in the Canadian Arctic are obvious both with respect to trans-Arctic correlations and, more locally, oil accumulation and mineral deposits.--Auth.

3-4053. Miller, Robert D., and Glenn R. Scott. LATE WISCONSIN AGE OF TERRACE ALLUVIUM ALONG THE NORTH LOUP RIVER, CENTRAL NEBRASKA: A REVISION: Geol. Soc. America, Bull., v. 72, no. 8, p. 1283-1284, Aug. 1961, 7 refs.

A radiocarbon age of 10,500±250 years B.P. (Before Present) from shell material near the base of a terrace along the North Loup River, Howard County, Nebraska, dates the alluvial sequence of silts and soils as late Wisconsin. The alluvium containing the shell material previously was reported as Kansan and Yarmouth in age.--Auth.

3-4054. Blake, Weston, Jr. RADIOCARBON DATING OF RAISED BEACHES IN NORDAUSTLANDET, SPITSBERGEN (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 133-145, 9 figs., 3 tables, Toronto, University of Toronto Press, 1961) 18 refs.

Raised beaches up to more than 100 m. above sea level are exceptionally well developed in the narrow, ice-free, coastal zone of Nordaustlandet. Radiocarbon determinations on imbedded driftwood, shells, and whale bones, as well as the tentative correlation of pumice fragments with dated pumice in Denmark and Norway, have provided a means of dating certain beach levels.

The pumice occurs at 3 different levels which serve as excellent horizons for correlating widely separated beaches. The uppermost level is particularly clearly defined and often occurs on a broad beach which also usually marks the upper limit of driftwood. Because

of differential uplift following deglaciation this beach rises from 5 m. at the outer coast to 10 m. in the inner parts of the fjords.

The radiocarbon dates on driftwood (4,000 to 7,000 years) show that this beach cannot be older than 7,000 years B. P., and the pumice has been dated elsewhere at 4,000 years B. P. Thus, the beach formed in the Hypsithermal interval (Tapes Sea). Wood at 36 m. and shells at 8-44 m. are dated at 9,000 to 10,000 years B. P., and shells at 44-47 m. are dated at 35,000 to 40,000 years B. P. The absence of material between 10,000 and 35,000 years (or more) in age is probably the result of a more extensive ice cover during that period.--Auth.

3-4055. Beschel, R. E. DATING ROCK SURFACES BY LICHEN GROWTH AND ITS APPLICATION TO GLACIOLOGY AND PHYSIOGRAPHY (LICHENOMETRY) (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1044-1062, 2 figs., Toronto, University of Toronto Press, 1961) 40 refs.

Most of the arctic and alpine crust lichens, especially the genera Rhizocarpon and Lecidea grow very slowly. This can be concluded indirectly from maximum diameters on rock surfaces of known age or repeated measurements. The over-all constant increment after an initially sigmoidal growth allows dating of rock surfaces exposed up to 1,000-4,500 years B.P., depending on the climatic conditions. Lichenometry permits relative dating of events which led to the exposure of bare rock surfaces within the age limit of the lichens in similar macroclimates. This can be converted to an absolute scale if one event is dated by other means, e.g. historical information, or if the growth rate is measured directly. From lichen measurements obtained in W. Greenland, the Alps, and the Ruwenzori Mountains, the synchronism of glacier behavior within the advance period of modern times (400 - 40 B. P.) appears very high. Early hypothermal moraines and boulder streams can be separated clearly from early modern ones, even if other morphological criteria fail.

Lichen growth rates are inversely proportional to the hygrocontinentality of the area. This permits calculation of this or similar combined climatic factors through lichenometry, or the prediction of lichen growth rates from the known climate. Lichenometry is especially useful where dendrochronology is impossible.--Auth.

5. PALEONTOLOGY

See also: Stratigraphy 3-4014.

3-4056. Saul, LouElla Rankin, and Richard B. Saul. FOSSILS - WHAT THEY MEAN AND HOW TO COLLECT THEM: Gems & Minerals, no. 288, p. 17-19, 52-57, 2 illus., map, chart, Sept. 1961, 23 refs.; reprinted from: California, Division of Mines, Mineral Information Service, v. 13, no. 7, July 1960.

Original paper was listed as GeoScience Abstracts 2-2866.

3-4057. Tasch, Paul. PALEOLIMNOLOGY: PART 2 - HARVEY AND SEDGWICK COUNTIES, KANSAS: STRATIGRAPHY AND BIOTA: Jour. Paleontology, v. 35, no. 4, p. 836-865, 6 figs., 2 pls., July 1961, 12 refs.

Several outcrop belts of Wellington conchostracan-bearing beds were discovered in Harvey and Sedgwick counties, Kansas. Data of the present study indicate that these belts are restricted, relatively narrow, and discontinuous. In turn, this reflects the distribution and characteristics of the Leonardian ponds represented. These were small (in some cases puddle size), areally nonpersistent, and very shallow.

A conchostracan-bearing horizon, the C_1 horizon, was found to be traceable throughout the 2-county area. At a critical exposure, (Annelly 1A), it was found to be 11± ft. above the Annelly gypsum. At this same exposure, but nowhere else in the 2-county area, 2 younger clam-shrimp horizons were found. Once the interval above the Annelly of the C_1 horizon was established, it was possible to locate clam-shrimp beds at predicted localities.

The biota associated with fossil clam-shrimp include: vertebrate remains (lizard scales, plates, teeth), arthropods (insects, ostracods, xiphosurans), mollusks (pelecypods, gastropods), plant remains (seeds, leaves, carbonized and silicified wood, charophytes, spores). The following new forms are figured and described: xiphosurans - Pringlia leonardensis, n. sp., Strongylocephalus charactis, n. gen., n. sp., Hypatocephala rugosa, n. gen., n. sp., Bifarius comptae, n. gen., n. sp.; mollusks - (gastropods) Patelloidea limnensis, n. gen., n. sp., Permoplanorboidea primus, n. gen., n. sp., Rugoplanorboidella sedgwickii, n. gen., n. sp., Wellingtonia producta, n. gen., n. sp.; (pelecypods) Stagnestesta solitaria, n. gen., n. sp., Rostrotortus dissimilis, n. gen., n. sp., Productae dunbaris, n. gen., n. sp., Elliptoidea vulgaris, n. gen., n. sp.

Variable salinity in, and differential evaporation of, contemporaneous Leonardian ponds can account for the observed sporadic occurrence of hopper crystals and cubic salt casts in clam-shrimp beds.

A method for deriving maximum clam-shrimp occupancy (in years) in different contemporaneous Leonardian ponds is outlined. Three different types of events are postulated to account for the observed distribution of the fresh-water and/or brackish-water mollusks: speciation in small pond situations, connections of discontinuous ponds by temporary drainage, and marine invasion.--Auth.

3-4058. Langston, Wann, Jr. A HADROSAURIAN ICHNITE: Canada, Natl. Mus., Nat. History Paper no. 4, 9 p., 3 figs., 1960, 9 refs.

A large ichnite preserved in an Upper Cretaceous shallow-water sandstone of the St. Mary River formation in southern Alberta, Canada, apparently records a pedal track of a hadrosaurian dinosaur. The broadly tridactyl foot of the animal possessed thick digital, but no distinct phalangeal, pads. A broad "heel" print suggests the presence of a massive tissue pad beneath the metatarsal bundle in the living dinosaur. There is evidence that a web extended between the digits.

Discovery of a hadrosaurian skeleton nearby shows that these dinosaurs existed in the region at approximately the time the footprint was made.--Auth.

3-4059. Lenz, Alfred C. DEVONIAN RUGOSE CORALS OF THE LOWER MACKENZIE VALLEY, NORTHWEST TERRITORIES (In: Raasch, Gilbert

O., ed. Geology of the Arctic...: v. 1, p. 500-514, 3 pls., table, Toronto, University of Toronto Press, 1961) 37 refs.

Eighteen species of rugose corals from the Devonian of the Mackenzie valley are dealt with, including one new genus and species, Aphroidophyllum howelli. All but one of the coral species occur within Middle Devonian beds, including 14 from the early Middle Devonian Hume formation, and 3 from the late Middle Devonian Ramparts limestone. The remaining coral species occurs within the Kee Scarp limestone and is probably of early late Devonian age.--Auth.

3-4060. Parodiz, J.J. NOTES ON VALVATIDAE FROM EARLY TERTIARY OF SOUTH AMERICA, WITH A NEW SPECIES: Nautilus, v. 75, no. 1, p. 16-18, pl., July 1961, 7 refs.

A new keeled species of Valvata (Mollusca: Gastropoda) is described from the Jahuel formation (Danian), from Nahuel Niyeu, Rio Negro province, Argentina. It recalls the subgenus Tropidina but cannot be assigned to any known subgenus; in fact no other keeled species of Valvata, living or fossil, are recorded from the Neotropical region. Although Valvata does not live today in South America, 3 early Tertiary species are recorded which resemble Valvata s.s.--J.W. Valentine.

3-4061. Cobban, William A. THE AMMONITE FAMILY BINNEYITIDAE REESIDE IN THE WESTERN INTERIOR OF THE UNITED STATES: Jour. Paleontology, v. 35, no. 4, p. 737-758, 5 figs., 3 pls., 10 tables, July 1961, 22 refs.

The ammonite family Binneyitidae Reeside is represented in the Western Interior region of the United States by at least 3 species of Borissiakoceras, 5 species of Binneyites, and 1 species of a new genus, Johnsonites. The family is known only from the lower part of the Upper Cretaceous. Johnsonites, which is represented only by the genotype, occurs in the oldest of the Cenomanian zones of the Western Interior region. Borissiaskoceras is found in the Cenomanian and in the lower part of the overlying Turonian. Binneyites has a range of about middle Turonian to lower Santonian. New species described are Johnsonites sulcatus, Borissiakoceras compressum, Binneyites carlilensis, B. nodosus, and B. rugosus.--Auth.

3-4062. Glenister, Brian F., and W.M. Furnish. THE PERMIAN AMMONOIDS OF AUSTRALIA: Jour. Paleontology, v. 35, no. 4, p. 673-736, 17 figs., 9 pls., 9 tables, July 1961, 116 refs.

Nineteen species of Permian ammonoids are known from Australia. Two occur in the Sydney Basin of New South Wales and the remaining species come from the 3 major sedimentary basins of Western Australia. Practically the whole of the Permian period is represented in Western Australia by marine or paralic sediments. The Australian ammonoid faunas are compared with those of the type-Lower Permian of the Ural Mountains and with the classic reference sections of the marine Lower and Upper Permian in other parts of the world. Subdivisions of the Permian system and correlations of the ammonoid-bearing strata are reviewed. It is concluded that in a world-wide sense the Permian system may be divided most usefully into the Asselian, Sakmarian, Artinskian, Guadalupian, and Dzhulfian stages. The Artinskian is subdivided into the Aktastinian and Baigendzhinian substages, and the Guadalupian comprises the Wordian and Capitanian substages. A two-fold series subdivision of the Permian system is utilized.

In Western Australia, Thalassoceras wadei Miller, Juresanites campbelli (Teichert & Glenister), J. jacksoni (Etheridge Jr.), Metalegoceras clarkei Miller, M. striatum Teichert, M. n. sp. (described herein), Uraloceras irwinense Teichert & Glenister, gen. indet. (described herein), and the new species Propopanoceras ruzhencevi are known from the Sakmarian; Propinacoceras australe Teichert, P. n. sp. (described herein), Pseudoschistoceras simile Teichert, Paragastrioceras wandageense Teichert, and Neocrimites sp. (described herein) occur in the Baigendzhinian substage; and Agathiceras applanatum Teichert, Pseudogastrioceras goochi Teichert, and Popanoceras sp. indet. (described herein) are known from the Wordian substage. In the Sydney Basin of New South Wales, Uraloceras pokolbinense (Teichert) is known from beds which are assumed to be of Sakmarian age, and Neocrimites meridionalis Teichert & Fletcher occurs in strata referred to the Baigendzhinian substage. Pseudoschistoceras gigas (Smith) from the Baigendzhinian Bitauni beds of Timor, is figured and compared with P. simile Teichert. --Auth.

3-4063. Kjellesvig-Waering, Erik N. THE SILURIAN EURYPTERIDA OF THE WELSH BORDERLAND: Jour. Paleontology, v. 35, no. 4, p. 789-835, 4 figs., 3 pls., table, July 1961, 77 refs.

A review of the eurypterid collections made by early collectors in the Silurian of the Welsh Borderland and originally described by J.W. Salter and Henry Woodward in their monographs. The family Pterygotidae is revised to include 2 genera, each of which is further divided into 2 subgenera. Thus, the genus Pterygotus Agassiz, 1844, is divided into Pterygotus (Pterygotus) Agassiz, 1844, and Pterygotus (Acutiramus) Ruedemann, 1935, whereas Erettopterus Salter, 1859, is considered a genus with 2 subgenera recognized, namely Erettopterus (Erettopterus) Salter, 1859, and Erettopterus (Truncatiramus), new subgenus. A new genus, Parahughmilleria, referred to the family Hughmilleriidae, is described, and the genus Hughmilleria Sarle, 1903, is divided into 2 subgenera: Hughmilleria (Hughmilleria) Sarle, 1903, and Hughmilleria (Nanahughmilleria), which is proposed as new. Eleven new species and subspecies are described. The taxonomic problems involving the genotype of Pterygotus are discussed and the species, Pterygotus problematicus Agassiz, is considered nomen vanum. The plates of the dorsal side of the metastoma, hitherto unknown, are described. A checklist of the Eurypterida of the Silurian of the Welsh Borderland is given.--Auth.

3-4064. Dunbar, Carl O. PERMIAN INVERTEBRATE FAUNAS OF CENTRAL EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 224-230, 2 figs., Toronto, University of Toronto Press, 1961) 8 refs.

Permian collections amassed by Dr. Lauge Koch and his co-workers in central E. Greenland include a predominance of brachiopods, with, secondarily, bryozoans and pelecypods. Two species of ammonites and one belemnite represent the cephalopods; gastropods, corals, sponges, and echinoderms are extremely minor constituents in the assemblage; and

fusulines are lacking.

Medlicottia and Cyclobus represent the ammonites. The belemnite, Dictyoconites groenlandica Fischer, is unique for the Permian. Among the 23 pelecypod species, the majority are facies-controlled, most notably the Posidonia of the black shales. The 38 brachiopod species represent 29 genera (including 17 illustrated in the accompanying plates). Most noteworthy is the association of Pleurohorridonia, Sowerbina, Spiriferella, and Choristites, as well as the absence of richtofenids, and their form-allies of lower latitudes. Similarities are close, on the other hand, with the faunas of Ellesmere Island and boreal Europe.

With the American Standard section, the Permian faunas of central E. Greenland have virtually nothing in common, but such affinities as do exist are with the basal Guadalupian of W. Texas and the high Guadalupian of Wyoming. With the type section in the Permian basin of Russia, there is no basis for correlation in view of the absence of normally marine Late Permian beds there.

Closest faunal ties are with the Zechstein of Germany and the Magnesian limestone of England, which establish the Greenland section as high, although not necessarily highest, Permian. This could merely be a consequence, however, of the fact that the latest Permian beds in England and Germany are nonmarine. In the Chideru formation of the Salt range of India, on the other hand, the ammonite Cyclobus occurs within a few meters of the Triassic boundary although absence of a Paleozoic-Mesozoic hiatus is postulated. Trümpy (in an accompanying article) also postulates a Permian-Triassic transition in Greenland.

In NE. Greenland, where the Permian is 350 m. thick and includes Wolfcampian (Sakmarian) fusulines in its lower part, the brachiopod fauna has nothing in common with that of central E. Greenland.--Auth.

3-4065. Raasch, Gilbert O., and others. THE SILURIAN AULACOPLEURA SOCIALIS IN THE YUKON TERRITORY (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 466-480, 5 figs., Toronto, University of Toronto Press, 1961) 12 refs.

Dark marly limestones and marls at Prong Creek (65°17'N. 135°45' W.), contain trilobites, graptolites, and brachiopods. The fauna shows affinities with that of the Cape Schuchert formation of N. Greenland, and also with that of the Sandpile group of northern British Columbia. The presence of Monograptus turriculatus (Barrande) indicates correlation with the early Gala-Tarannon of the standard European sequence.--Auth.

3-4066. Jarvik, Erik. DEVONIAN VERTEBRATES (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 197-204, 2 figs., table, Toronto, University of Toronto Press, 1961) 10 refs.

The large collections of fossil vertebrates, taken since 1929 from the Middle and Upper Devonian Old Red deposits of E. Greenland during the Danish expeditions under the leadership of Dr. Lauge Koch, include representatives of all the principal groups of lower vertebrates. Most famous are the Ichthyostegalia which are the oldest and most primitive tetrapods and bridge the gap between fish and tetrapod. Important material has also been collected of phyllolepids, antiarchs, dipnoans, osteolepiforms, and porolepiforms. Excellent porolepiform material, found in 1956 in the Middle Devonian of Canning Land, shed a considerable new light on the ancestry of the Urodela.--Auth.

3-4067. Stensiö, Erik. PERMIAN VERTEBRATES (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 231-247, 2 figs., Toronto, University of Toronto Press, 1961) 24 refs.

A brief account of the fish fauna of the Upper Permian of E. Greenland with notes on the stratigraphic range of the individual forms is presented. In addition, the writer deals with the squamation of the E. Greenland edestids, which was found to be of great general significance from the point of view of comparative anatomy in proving conclusively that the "placoid" scales of the elasmobranchs are secondary formations evolved from ordinary, zonally growing scales of the same nature as those in the ostracoderms, acanthodians, crossopterygians, and early actinopterygians. Finally, it could also be established that the individual areal zones in zonally growing scales are made up of minor component scales of which the simplest ones have been termed lepidomoria. The opinion maintained since the time of O. Hertwig (1874-1879) that the placoid scales would be simple, primitive scale formations has hence turned out to be wrong, a condition which is of great general importance inter alia for the interpretation of the teeth and for a proper understanding of the ontogenetic development and modifications of the exoskeleton in all groups of vertebrates.--Auth.

3-4068. Thalmann, Hans E. AN INDEX TO THE GENERA AND SPECIES OF THE FORAMINIFERA, 1890-1950: 393 p., Stanford, California, George Vanderbilt Foundation, Stanford University, 1960.

A continuation of Index to the Genera and Species of the Foraminifera by Charles Davies Sherborn (Smithsonian Institution, Smithsonian Miscellaneous Collections, no. 856, pt. 1, A to NON, Nov. 1893; no. 1031, pt. 2, NON to Z, Feb. 1896) which included all genera and species of Foraminifera known since the Middle Ages up to and including Dec. 1889. The present compilation has been carried out for more than 30 years. Every effort was made to deal with all the literature on Foraminifera during the 1890-1950 period, but many publications of Russian authors and others were unavailable. In an appendix to the index is a list of Species inquirendae sive dubiae which includes names of Foraminifera the validity of which from a nomenclatorial point of view could not be established, and which may include Nomina nuda. --From introd.

3-4069. McGill, Peter C., and D. M. Loranger. MICROPALAEONTOLOGICAL (FORAMINIFERA) ZONATION OF THE SANS SAULT GROUP, LOWER MACKENZIE RIVER AREA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 516-531, 6 figs., Toronto, University of Toronto Press, 1961) 8 refs.

Sediments from the Sans Sault group in the Norman Wells area have yielded a varied and well-preserved fauna of Albian age. The restricted time ranges of certain diagnostic forms permit zonation of the Sans Sault group. The same zones are found in Lower Cretaceous sediments along the lower Anderson River. The more diagnostic Foraminifera are described and illustrated and compared with relative North American species.--Auth.

3-4070. Ethington, R. L., and others. UPPER DEVONIAN CONODONTS FROM BIGHORN MOUNTAINS, WYOMING: Jour. Paleontology, v. 35, no. 4, p. 759-768, map, pl., table, July 1961, 46 refs.

A small collection of Upper Devonian conodonts from Cottonwood Canyon on the W. side of the Bighorn Mountains, Wyoming, is described. The majority of the species are the same as those reported from the Darby formation in the Wind River Mountains in western Wyoming. General correlation with the Saverton of Missouri and part of the Clymenia-Stufe of Europe is indicated.--Auth.

3-4071. Moore, Raymond C., ed. TREATISE ON INVERTEBRATE PALEONTOLOGY. PART Q. ARTHROPODA 3. CRUSTACEA, OSTRACODA, by R.H. Benson and others: 442 p., 334 figs., New York and Lawrence, Kansas, Geological Society of America and University of Kansas Press, 1961, refs.

This is the third of a projected 4-volume unit dealing primarily with fossil Arthropoda, and is confined to the Ostracoda. The introductory section (p. 2-99) has chapters on the morphology of living Ostracoda, reproduction, ontogeny, shell morphology, dimorphism, orientation, a glossary, the ecology of ostracode assemblages, techniques for preparation and study of fossil ostracodes, the identification of fossil ostracodes in thin section, a revised classification, and a summary of the classification and stratigraphic distribution of the group. Most of the remainder of the volume (p. 99-421) consists of systematic descriptions of 896 genera and 15 subgenera of ostracodes. No new genera are proposed, although many families and other higher taxa are new. The descriptions consist of the generic name, author's name and date, type species, synonymy, diagnosis, age range, and geographic range. Most genera are illustrated, many with new figures of the holotypes of type species. In addition, range charts of genera are given with the discussions of the superfamilies. An addendum (p. 421-422) lists taxa which are not discussed either in this volume or in the Russian paleontological treatise (Osnovy Paleontologii), and a supplement (p. 422-429) summarizes the Russian taxonomic units and compares the classification used in the Russian treatise with that in this volume. The Russian treatise is concerned primarily with genera found in the Soviet Union, whereas this volume takes into consideration ostracode genera of the entire world.--J. N. Berdan.

3-4072. Krutak, Paul R. JACKSON EOCENE OSTRACODA FROM THE COCOA SAND OF ALABAMA: Jour. Paleontology, v. 35, no. 4, p. 769-788, 2 figs., 3 pls., table, July 1961, 52 refs.

This paper deals with a taxonomic study of the Ostracoda from a portion of the lower Jackson Eocene sequence (Cocoa sand) in Choctaw County, Alabama. Thirty-four species are figured and described. Eleven of the 34 are described as new; they include Cytherelloidea cocoaensis, Loxoconcha concentrica, Loxoconcha watervalleyensis, Loxochoncha cocoaensis, Cushmanidea keyserensis, Cushmanidea papula, Cushmanidea serangodes, Acuticythereis cocoaensis, Cytheromorpha calva, Triginglymus gnythophoreus, and Absonocytheropteron watervalleyensis. Konarocythere, nom. nov., is proposed for Budaia Mehes, 1941, preoccupied.--Auth.

3-4073. Swain, Frederick M. OSTRACODA FROM THE PLEISTOCENE GUBIK FORMATION, ARCTIC COASTAL PLAIN, ALASKA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 600-606, 2 figs., Toronto, University of Toronto Press, 1961) 13 refs.

Ostracoda were obtained from drill cores and shot hole tests in the Quaternary Gubik formation at several localities in northern Alaska. At and immediately S. of Barrow the ostracodes of the Gubik are predominantly marine, neritic, cold-water types, but at 4 horizons fresh-water or nearshore types occur. In the Simpson core test no. 1 on the E. side of Dease Inlet, the Gubik ostracodes are neritic species; the same is true of core tests on the W. side of Smith Bay, shot holes in the Teshekpuk Lake area (with a few fresh-water exceptions), in shot holes on Fish Creek S. of Harrison Bay, and in the Sentinel Hill core test no. 1 on Colville River, near lat. 70°N.

The Gubik ostracodes of the Oumalik core test no. 2, W. of Oumalik River, and in shot holes near Ikpikpuk River all are fresh, standing-water types.

The main shoreline during Gubik time based on these few observations, evidently lay roughly parallel to the present coast and 30 to 50 mi. inland from a position S. of Ocean Point on Colville River northwestward, S. of, but near, Teshekpuk Lake, S. of Dease Inlet, and a little S. of Barrow.

Illustrations of, and brief remarks concerning, the ostracode species are provided.--Auth.

3-4074. Konishi, Kenji, and John L. Wray. EUGONOPHYLLUM, A NEW PENNSYLVANIAN AND PERMIAN ALGAL GENUS: Jour. Paleontology, v. 35, no. 4, p. 659-666, 2 figs., pl., July 1961, 19 refs.

A new genus of calcareous algae, Eugonophyllum, based on the type species E. johnsonii, n. sp., from rocks of Virgil age (Upper Pennsylvanian) in New Mexico, resembles Anchicodium Johnson and Ivanovia Khvorova, but differs in having the cortex differentiated into an inner and outer layer. The inner cortex (subcortex) of the new genus is composed of prominent anastomosing utricles extending parallel to the surface of the blade. A second species, E. huecoense, n. sp., is described from Wolfcamp rocks (Lower Permian) in New Mexico. Anchicodium magnum Endo is referred to this new genus. The blade-shaped thallus of Eugonophyllum had an erect growth habit. Perforations in the thallus and presumed reproductive organs are found in Eugonophyllum but are unknown in Anchicodium and Ivanovia. This new genus is interpreted as having generally inhabited the inner sublittoral environment at a depth below normal wave agitation. Eugonophyllum and the related codiacean genera, Anchicodium and Ivanovia, are important world-wide contributors to both biohermal and nonbiohermal carbonate facies of Pennsylvanian and early Permian age.--Auth.

3-4075. Harris, T. M. THE RHAETO-LIASSIC FLORA OF SCORESBY SOUND, CENTRAL EAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 269-273, Toronto, University of Toronto Press, 1961) 16 refs.

The geologically simple, plant-bearing strata of Scoresby sound have many fossiliferous horizons, each with a random selection from 1 of 2 large floras, the older of which correlates with Rhaetic, the younger with Liassic α.

The very similar flora from S. Sweden has been re-analyzed and its numerous "zones" reduced to 2, corresponding to the 2 in E. Greenland; and fresh studies of Liasso-Rhaetic rocks of other parts of

Europe have shown widespread similarity. Outside Europe, and especially in eastern Asia, many Greenland species occur, but it now seems that correlation with a period as brief as the Rhaetic was premature. Many of the Greenland megaspores have now been recognized in Europe and prove to be valuable zone fossils.--Auth.

3-4076. Beals, H.O., and Wilton N. Melhorn. AN EXTINCT CONIFER, LARIX(?) PLEISTOCENICUM, N.SP. FROM YARMOUTH INTERGLACIAL DEPOSITS OF INDIANA: Jour. Paleontology, v. 35, no. 4, p. 667-672, fig., 2 pls., July 1961, 13 refs.

During spillway construction at the Brush Creek reservoir near Butlerville, Jennings County, Indiana, Yarmouth interglacial floodplain deposits were exposed in a buried valley. Fragments of wood from the forest bed were first identified as spruce, but careful examination revealed several unusual anatomical features not found in living North American conifers. The wood specimens show resemblance to both Larix and Picea, but because other features favor Larix more closely, the name Larix(?) pleistocenicum Beals, n.sp., is proposed for this Pleistocene coniferous wood.

Few published descriptions of Pleistocene wood are available. Proper preparation and examination of wood specimens is suggested to determine if woody material is of value as a means of correlation of Pleistocene glacial and interglacial deposits.--Auth.

6. GEOPHYSICS

See also: Geomorphology 3-3990; Structural Geology 3-3996; Igneous and Metamorphic Petrology 3-4179, 3-4180; Geohydrology 3-4205; Mineral Deposits 3-4235, 3-4236; Fuels 3-4259 through 3-4265.

3-4077. U.S. Air Force, Cambridge Research Center, Geophysics Research Directorate. RESEARCH AND DEVELOPMENT IN THE FIELD OF GEODETIC SCIENCE. By Clair E. Ewing: Its: Air Force Surveys in Geophysics, no. 124, 58 p., 15 figs., 2 tables, 1960, 22 refs.

This report briefly surveys significant research and development activities in geodesy, namely, arc measurements, electronic surveying, eclipses and occultations, moon camera, satellites, and gravity measurements.--Auth.

3-4078. Paterson, Norman R. AN INTEGRATION TECHNIQUE FOR AIRBORNE GRAVITY GRADIENT MEASUREMENTS: Geophysics, v. 26, no. 4, p. 474-479, 4 figs., Aug. 1961, 4 refs.

For some purposes it may be desirable to work with the gravity force g rather than its vertical gradient g'. A simple method has been tested by which measurements of g' on a plane surface can be integrated to produce values of g anywhere in space above the plane of measurement. The method appears to show promising results.--Auth.

3-4079. Chinnery, M.A. TERRAIN CORRECTIONS FOR AIRBORNE GRAVITY GRADIENT MEASUREMENTS: Geophysics, v. 26, no. 4, p. 480-489, 6 figs., 6 tables, Aug. 1961, 7 refs.

A method is given for the calculation of terrain corrections for airborne measurements of the vertical gradient of gravity. This includes a short account of the theory concerned, a description of the practical procedure, a complete set of numerical tables, and some examples of their application. The method described is shown to be very flexible, both with regard to aircraft height and to complexity of topography. Some discussion is also given of the magnitude of topographic effects on the gravity gradient, and it is shown that terrain corrections are in general more important here than in normal gravity work.--Auth.

3-4080. Colley, G.C. GRAVITY SURVEYS IN HEAVY SAND DUNES: Geophysics, v. 26, no. 4, p. 490-498, 4 figs., Aug. 1961.

The paper discusses the problems involved in desert surveys under the headings of "Access" and "Correction of Gravity Data." The types of sand formation are described. In planning a survey the importance of reconnaissance, aerial photographs, and the provision of suitable equipment are stressed. The advantages and disadvantages of motor transport, light aircraft, helicopters, and the operational procedures used with each are discussed. Terrain corrections are necessary on most stations and suggestions are given for their determination. The different densities of the dune sand and the "floor" introduce a problem in the determination of the Bouguer Correction. A method is given whereby close estimates of the sand thickness can be found by contouring on the "floor" or on minimum elevations. The resulting Bouguer values after computation are as regular as those found in areas of small elevational changes.--Auth.

3-4081. Kazinsky, V.A. INTERPRETATION OF GRAVITATIONAL FIELDS PRODUCED BY STEEPLY DIPPING GEOLOGICAL BODIES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 384-388, 2 tables.

In geophysical prospecting, one often deals with fields generated by steeply dipping bodies which sometimes penetrate into relatively great depths. This particular character of bedding of many geological bodies was first taken into account in geophysics with the development of a more convenient theory of the approximation of geophysical anomalies and reductions made on the basis of an oblique system of coordinates. The main advantage of the suggested theory lies in its simplicity and the absence of ambiguity in its application. The theory is outlined and examples given.

The author concludes that the example of determining a sloping parallelepiped can serve as a clear proof that oblique coordinates represent the soundest geometrical basis for the approximation of physical fields produced by steeply dipping geological bodies of an arbitrary shape.--L. M. Dane.

3-4082. Garland, G.D., and others. GRAVITY MEASUREMENTS OVER THE SOUTHERN ROCKY MOUNTAIN TRENCH AREA OF BRITISH COLUMBIA: Jour. Geophys. Research, v. 66, no. 8, p. 2495-2505, 5 figs., table, Aug. 1961, 27 refs.

A series of negative gravity anomalies found along the southern part of the Rocky Mountain Trench in Canada is interpreted to be the effect of relatively deep basins in the trench floor. These are apparent-

ly filled with light material and are separated from each other by regions of only thin cover over bedrock of normal density. The pattern obtained is very suggestive of a system of longitudinal and transverse faults, and the gravity field is therefore consistent with the theory that the trench, in this vicinity, was produced chiefly by downfaulting.--Auth.

3-4083. Ingall, L. N., and R. J. Copeland. OPERATIONAL REPORT ON A GRAVITY METER SURVEY CONDUCTED ON THE ARCTIC COASTAL PLAIN (In: Raasch, Gilbert O., ed. Geology of the Arctic ...: v. 2, p. 1149-1152, Toronto, University of Toronto Press, 1961)

This report describes the operational aspects of a gravity meter survey conducted during June and July 1959 on the Arctic Coastal Plain [N. of Inuvik, Northwest Territories]. Aspects discussed include personnel, logistics, equipment, mode of operation, and operational statistics.--Auth.

3-4084. Weber, J. R. COMPARISON OF GRAVITATIONAL AND SEISMIC DEPTH DETERMINATIONS ON THE GILMAN GLACIER AND ADJOINING ICE-CAP IN NORTHERN ELLESMERE ISLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 781-790, 6 figs., table, Toronto, University of Toronto Press, 1961) 7 refs.

During the summers of 1957 and 1958, 12 bedrock profiles on the Gilman Glacier and on the ice-cap between Gilman Glacier and Mount Oxford were determined from seismic reflections. During the second field season more than 200 gravity stations were established over the same general area. The regional Bouguer anomaly was calculated from the known ice thickness at a few selected locations along the seismic profiles, and was then extrapolated for the whole area. With this information and with assumed specific gravities of ice and bedrock of 0.9 and 2.71 respectively, the ice thickness was calculated from the gravity measurements. Agreement between the bedrock profiles as determined by the 2 methods was very close. It is concluded that a gravity survey, when supplemented by a few seismic soundings, can give a good indication of the shape of the bedrock and the ice thickness.--Auth.

3-4085. Mann, Virgil I., and Frank S. Zablocki. GRAVITY FEATURES OF THE DEEP RIVER-WADESBORO TRIASSIC BASIN OF NORTH CAROLINA: Southeastern Geology, v. 2, no. 4, p. 191-215, 12 figs., June 1961, 18 refs.

Over 1,200 gravity stations have been located in the Deep River-Wadesboro Triassic basin of North Carolina. Simple Bouguer anomaly maps suggest that the basin is not a significant or sharp anomaly in the gravitational field of this state. To outline the basin, one must resort to gravity profiles. A study of detailed profiles normal to the axis of the basin suggests that the basin locally reaches a depth of at least 8,000 ft., and in places has grabenlike features. The basin was traced under the Coastal Plain overlap by locating the easily recognized discontinuity in the profile where it represents the Jonesboro fault. In the future, specific rock types in the Piedmont may possibly be outlined by the gravity profile technique.--Auth.

3-4086. Lum, Daniel. GRAVITY MEASUREMENTS EAST OF THE BLACK HILLS AND ALONG A LINE FROM RAPID CITY TO SIOUX FALLS, SOUTH DAKOTA: South Dakota, State Geol. Survey, Rept. Inv. no. 88, 26 p., 2 figs., map (in pocket), 1961, 11 refs.

Gravity measurements were carried out in South Dakota during the summer of 1959 by the State Geological Survey, as part of a regional gravity study which is being supported by a National Science Foundation grant. A Simple Bouguer gravity anomaly map was compiled from data of more than 500 stations in an area of approximately 2,500 sq. mi. A gravity traverse was established from the Black Hills eastward onto the Sioux uplift.

The configuration of the basement surface and the variations of intrabasement lithology, as suggested by the gravity measurements and some magnetic studies, are discussed. Interpretations of the gravity data are preliminary at this time.--Auth.

3-4087. Carnegie Institution of Washington. ANNUAL REPORT OF THE DIRECTOR OF THE DEPARTMENT OF TERRESTRIAL MAGNETISM, 1959-1960: 291 p., 66 figs., 10 pls., 20 tables, Washington, D.C., 1960, 33 refs.; reprinted from: Carnegie Inst. Washington, Year Book 59.

A summary of research done in the following fields: radio astronomy; the earth's crust (seismic studies, mineral age measurements and earth history); equatorial electrojet; cosmic-ray investigations; lectures on geophysics in Peru; nuclear physics; biophysics. A summary of the program for studies on the earth's crust is given below.

This program aims to provide data and ideas for further illumination of geological history, especially in the long epochs before the Cambrian period. The mass spectrograph work on isotopes, measuring ages of minerals in ancient rocks, completed a long series of North American samples and measured specimens from northern Europe and the Middle East. The results gave further indication of several disturbed periods of great tectonic activity, during 2 billion years of Precambrian time, separated by long epochs that were relatively quiet. The seismic studies, which seek clues to geological history by characterizing the features of the earth's crust as we find it now, have included an expedition to Montana, in collaboration with the University of Wisconsin, for studies of explosion waves propagated in the crust, and the installation of 11 recording vertical seismographs, suitable for recording weak local earthquakes, in Peru, Bolivia, and Chile. These instruments are intended to examine the very large attenuation of seismic waves under the Andes ranges and the Altiplano which was observed by the Carnegie-IGY Expedition there in 1957. This work requires a large measure of international cooperation and simultaneous observation, and may take several years to bear fruit, despite the fact that some of the stations are recording more than 30 small quakes per day. The explosion seismology work of the department over the past dozen years has also become a matter of considerable official interest by reason of the Geneva Conference and the problems encountered in detecting buried explosions.--From p. 195.

3-4088. Lapina, M. I. ON THE USE OF VARIATIONS OF A GEOMAGNETIC FIELD FOR DETERMINING THE MAGNETIC SUSCEPTIBILITY OF STRONGLY-MAGNETIC ROCKS IN SITU: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 266-269, 3 figs., 2 tables, 2 refs.

For the determination of the mean value of $\varkappa$ we can use variations of the vertical component of the natural geomagnetic field having periods of several minutes or more. The use of larger periods, however, will be necessary in order to permit us to disregard the influence exerted by electric currents. In the process of finding $\varkappa$ we meet with difficulties involved not only in measuring the amplitudes of variations in the anomalous and normal fields which can presently be overcome with highly-sensitive instruments for the recording of variations, but mainly in determining the constant coefficients A, dependent upon the dimensions of the disturbing bodies. In determining a coefficient A, the modern methods of interpreting data of magnetic prospecting can, under favorable conditions, assure an accuracy up to 10 - 30%, and, consequently, a similar accuracy in finding $\varkappa$.--Auth. concl.

3-4089. Gregory, A. F., and others. GEOLOGICAL INTERPRETATION OF AEROMAGNETIC PROFILES FROM THE CANADIAN ARCTIC ARCHIPELAGO (In: Raasch, Gilbert O., ed. Geology of the Arctic ...: v. 1, p. 427-437, 5 figs., Toronto, University of Toronto Press, 1961) 7 refs.

Nine thousand line miles of widely-spaced aeromagnetic profiles were flown in conjunction with "Operation Franklin," a geological exploration program carried out by the Geological Survey of Canada.

The regional interpretation of these geophysical data substantiates the general geological structures recognized by field geologists and provides additional detail. Thus the Boothia arch appears to be an imperfectly developed horst extending at depth as far N. as the SE. corner of Bathurst Island. Related basement uplifts may underlie the southern portion of the Cornwallis fold belt. Several of the lower Paleozoic basins may occupy, in part, graben or fault block structures. Maximum depths to basement in these basins are greater than 10,000 ft. A W.-trending regional fault in Lancaster Sound appears to parallel the S. coast of Devon Island and may offset the northern end of the Boothia arch. The magnetic data from the Sverdrup basin suggest that igneous dike activity and extensive folding occur only within the eastern half of this basin, although sheets of basic rock are probably present in much of the western half. A structural complex similar to the Parry Islands and central Ellesmere fold belts may bound the basin on its NW. side.

Magnetic anomalies which in profile show a central minimum with marginal maxima are characteristic of known gypsum domes in this area. Variform magnetic expressions result from sills in the strata which are variously upturned by intrusion of the domes. It is concluded that aeromagnetic surveys will provide useful data for the geological study of this region.--Auth.

3-4090. Mason, Ronald G., and Arthur D. Raff. MAGNETIC SURVEY OFF THE WEST COAST OF NORTH AMERICA, 32°N. LATITUDE TO 42°N. LATITUDE: Geol. Soc. America, Bull., v. 72, no. 8, p. 1259-1265, 4 figs., fold. map, Aug. 1961, 6 refs.

A ship-towed magnetometer survey of an area 250-300 mi. wide off the foot of the continental slope along the coast of California has revealed a narrow pattern of anomalies of about 400 gammas magnitude trending N.-S. for more than 500 mi. The pattern is interrupted at the known faults and elsewhere; offset of the pattern at the Murray fault suggests a right-lateral displacement of about 84 nautical mi. The anomalies are such as might be expected of slablike structures underlying the ocean floor; geological possibilities include basic lava flows, topography of the main crustal layer, and intrusion of ultrabasic material from the mantle.--Auth.

3-4091. Raff, Arthur D., and Ronald G. Mason. MAGNETIC SURVEY OFF THE WEST COAST OF NORTH AMERICA, 40°N. LATITUDE TO 52°N. LATITUDE: Geol. Soc. America, Bull., v. 72, no. 8, p. 1267-1270, fig., fold. map, Aug. 1961, 5 refs.

An extensive high-resolution magnetic survey of total field at sea level reveals unusual N.-S. lineations and much crustal faulting. Computations indicate that the linear pattern is due to strongly magnetized mafic rocks beneath the sediments.--Auth.

3-4092. Devitsyn, V. M., and others. THE EFFECT OF NONUNIFORM INTENSITY OF MAGNETIZATION OF A BODY OF CONSTANT SUSCEPTIBILITY ON THE INTERPRETATION OF MAGNETIC ANOMALIES BY SIMPLE METHODS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 274-276, 6 figs., 2 refs.

The authors have studied the nonuniform magnetization of an infinitely great stratum of great submersion, which can be likened to the stratum of ferruginous quartzites in the Shchigry district [Kursk magnetic anomaly, U.S.S.R.]. Nonuniform magnetization is understood as the magnetization of a uniform isotropic body of constant susceptibility in a uniform field. It has been demonstrated that nonuniform inductive magnetization of this type (like normal inductive magnetization) cannot explain the magnitude of the KMA anomalies for the known values of $\varkappa \approx 0.2$ CGSM. The magnitude of the remanent magnetization must also be taken into account to explain the KMA anomalies.

A comparison of the form of the $Z_a/(Z_a)_{max}$ curves for the cases of nonuniform and uniform magnetization shows that the distribution of the field in the first case is somewhat different to the field in the second case and is more close to the observed curve. Analysis of the method of characteristic points and the method of tangents shows that there is a difference of 10-20% between interpretation results by these methods for the cases of nonuniform and uniform magnetization. In practice, however, the error may be considerably less. We note that all this refers to strongly magnetized rocks with $\varkappa > 0.1$ CGSM. The results of the theory of uniform magnetization still hold for weakly magnetized rocks.--Auth. concl.

3-4093. Kalashnikov, A. G. THE USE OF MODELING TO SOLVE A CONVERSE PROBLEM OF MAGNETIC PROSPECTING: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 223-225, 3 figs., 8 refs.

The possibility of using experimental methods to interpret observations in magnetic prospecting is demonstrated from modeling of the Shchigry magnetic anomaly of the KMA [Kursk magnetic anomaly], U.S.S.R.

It follows that the distribution of the Z component of the Shchigry anomaly can be explained by: 1) the nonuniform intensity of magnetization of the ore body owing to its heightened magnetic susceptibility; 2) the considerable remanent magnetization of the ferru-

ginous quartzites, for which the mean value of Q is of the order of 8.5; 3) nonuniform distribution of the magnetized rocks in the upper parts of the ore body, where Q in some varieties of rock reaches 10-12 units.

Thus, when the modeling method is applied to the interpretation of one of the magnetic anomalies of the KMA it provides a satisfactory explanation of the physical causes for the origin of this anomaly.--From auth., p. 223, 224.

3-4094. [Kopaev, V. V., and T. A. Martynova.] [ON THE USE OF LABORATORY MEASUREMENTS OF THE MAGNETIC PROPERTIES] OF FERRUGINOUS QUARTZITES TO INTERPRET THE MAGNETIC ANOMALIES OF THE KMA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 355-362, 7 figs., 4 tables, 8 refs.

The Oskolets magnetic anomaly of the KMA [Kursk magnetic anomaly, U.S.S.R.] is due in the main to the remanent magnetization of ferruginous quartzites. The intensity of the anomaly is in full accord with the magnitude of the total magnetization of the quartzites as measured from core sample specimens.

The upper part of the quartzite bed, which has undergone oxidation and weathering, has considerably less remanent magnetization than the deep-seated parts of the same bed. Moreover, it is apparent that the boundary of the oxidized zone as determined from the magnitudes of remanent magnetization lies somewhat deeper than the same boundary determined from the magnitudes of magnetic susceptibility. This explains the previously-held erroneous view that the intensity of the anomaly failed to conform to the intensity of magnetization of the ferruginous quartzites.

Local reductions in the strength of the anomalous field along the bed axis, especially in the vicinity of a bend or displacement in the latter, are due to a decline in remanent magnetization.

Decline in the remanent magnetization of quartzites when the mineralogical composition, percentage content of magnetite, and internal structure of the rock remain the same is probably due to the effect of stresses on the quartzites in bending and fault zones.

It would appear that lines of heightened tectonic activity can be plotted from the position of local minima associated with ferruginous quartzites in the KMA.--Auth. concl.

3-4095. Brodskaya, S. Yu. MAGNETIC STABILITY OF REMANENT MAGNETIZATION IN ROCKS WITH TWO FERROMAGNETIC COMPONENTS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 270-273, 6 figs., 4 refs.

The demagnetizing field H_c' of a dual-component rock is a function of the concentration of the components.

In the case of a dual-component mixture the demagnetizing field can be used as a laboratory criterion of the directional stability of the remanent magnetization.

In view of the good agreement of the $S = f(H_c')$ curve with the results obtained by Petrova and Zhilyaeva in regard to natural rocks, dual-component specimens possessing a demagnetizing field $H_c' > 40$ oersteds can be regarded as stable. The direction found in these specimens is near to that of the original magnetizing field. Dual-component specimens possessing a demagnetizing field $H_c' < 40$ oersteds can probably also be used for paleomagnetic investigations, but must first be magnetically cleaned.--Auth.. concl.

3-4096. Bidgood, D. E. T., and W. B. Harland. PALAEOMAGNETIC STUDIES OF SOME GREENLAND ROCKS (In: Raasch, Gilbert O., ed. Geology of the Arctic. . . : v. 1, p. 285-292, 2 figs., 2 tables, Toronto, University of Toronto Press, 1961) 12 refs.

Field work on Dr. Koch's 1957 expedition to E. Greenland yielded results which will be published fully in Meddelelser om Grønland but are summarized here for this symposium. Data for late Precambrian, Devonian, lower Carboniferous, Permo-Carboniferous, Eotriassic, and Upper and Middle Triassic are given. From these, pole positions are inferred similar to those derived from North America but suggesting a systematic displacement.--Auth.

3-4097. Douloff, Artel A. THE RESPONSE OF A DISK IN A DIPOLE FIELD: Geophysics, v. 26, no. 4, p. 452-464, 14 figs., Aug. 1961, 13 refs.

Electromagnetic type curves are basic tools in mining geophysics in reducing ambiguity of interpretation. To this end, a mathematical solution is given for the quasi-static response of an infinitely conducting disk in a dipolar magnetic field. The solution, which emerges as a series solution of Laplace's equation in oblate spheroidal coordinates, converges rapidly enough only in certain ranges of radii of the disk. Sommerfeld's image method leads to an alternate solution that is exact. For finite conductivity, the mathematics becomes rather unwieldy, so experimental modelling produced the type curves in this range. By using high frequencies and Al disks, "infinitely" conducting models were constructed to check the theoretical solutions. All computation was done on an IBM 650 digital computer.--Auth.

3-4098. Yungul, S. H. MAGNETO-TELLURIC SOUNDING THREE-LAYER INTERPRETATION CURVES: Geophysics, v. 26, no. 4, p. 465-473, 12 figs., Aug. 1961, 3 refs.

To interpret the magneto-telluric sounding data in terms of layering in the subsurface, one needs a catalog of "standard" curves. The purpose of this paper is to present such a catalog for the 3-layer cases. The calculations were done by incorporating the formulas given by Cagniard into a digital computer program.

The catalog consists of 117 apparent-resistivity-vs.-period curves representing 10 resistivity combinations. In each case the third, semi-infinite medium represents the "basement" with infinite resistivity. In addition, a set of 2-layer curves for the total range of resistivity combinations is also given. The procedure in using the curves is briefly explained.--Auth.

3-4099. Kolmakov, M. V. AN INTERESTING PROPERTY OF THEORETICAL MAGNETO-TELLURIC SOUNDING CURVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 376-378, 4 figs., 3 refs.

1) The symmetry of MTS curves has been proved for specified relations between the parameters of geologic sections. 2) The symmetry characterizes ρ_k/ρ_1 and φ curves. 3) Symmetry reduces the work of calculation and the number of curves to one-half. 4) The identical shapes of symmetric curves provide a graphic means of comparing MTS resolving power for different types of sections.--Auth. concl.

3-4100. Kolmakov, M.V., and N.P. Vladimirov. ON THE EQUIVALENCE OF MAGNETO-TELLURIC SOUNDING CURVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 349-354, 12 figs., 3 refs.

Our investigation of the equivalence conditions for the magneto-telluric sounding of type K sections results in the following conclusions.

Sections that include a high-resistivity layer reveal the following peculiarity. As we have shown, when $\nu_1 \leq 24$ the resistivity of the layer affects MTS curves practically only for $\mu_1 \leq 19$. When ρ_2 is larger the configuration of the curves depends only on the layer thickness. When ν_1 is decreased this property is observed for smaller μ_1.

Since MTS curves lack the equivalences characteristic of VES, it is difficult to determine ρ_2 or even its limits. The interpretation therefore requires knowledge of ρ_2. Two cases are possible: a) if ρ_2 does not differ greatly from the resistivity of the enclosing bed, only the thickness of a thin layer can be determined precisely. For thick layers, the determination of h_2 requires that the precise value of ρ_2, and not merely its order of magnitude, be known; b) if ρ_2 differs considerably from the resistivity of the containing layer, h_2 can be determined very precisely for thick as well as for thin layers. For this purpose only the order of magnitude of ρ_2 is required, not its precise value.

Magneto-telluric sounding must be combined with other electrical prospecting methods, especially vertical electrical sounding.

In magneto-telluric sounding, phase measurements furnish no information not already obtained by amplitude measurements for interpreting a geologic section, although the duplication can be justified.--Auth. concl.

3-4101. Schaub, Yu. B. ON A QUANTITATIVE MEASURE OF THE INFORMATION ACQUIRED BY AIRBORNE ELECTROMAGNETIC PROSPECTING METHODS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 232-236, 7 figs., 4 refs.

It is shown that a single measure can be used to estimate the amount of information acquired by different airborne electromagnetic prospecting methods. A conducting sphere is used as an example in comparing the 4 principal survey methods - induction, an infinitely long cable, a rotating magnetic field, and measurement of the angle of inclination of the polarization plane of the earth's natural alternating magnetic field.--Auth.

3-4102. Off, Theodore. ELECTRIC LOG INTERPRETATION IN EXPLORING FOR STRATIGRAPHIC TRAPS IN SHALY SANDS: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1412, Aug. 1961, 2 refs.

Discussion of GeoScience Abstracts 3-1218. The use of a shaliness factor (m_s) and a saturation ratio (S_{wi}/S_w) by Slack and Otte is a significant contribution. To those of us not having access to a computer, their equations should be put in the form of a simple nomograph, following De Witte. His $\underline{a}$ factor = $m_s/2.15 m_f$. By using his nomographs this $\underline{a}$ factor can be determined, and from it m_s. His nomograph also includes the saturation ratio (S_{wi}/S_w).

If the shaliness factor is used only as a mappable parameter, it can be redefined as $\underline{a}/R m_f$ instead of a x 2.15m_f. Numerical values are changed but ratios between the "shaliness factors" are substantially unaffected.--F. E. Kottlowski.

3-4103. Burr, S.V. THE SELF-POTENTIAL METHOD FOR THE PROSPECTOR. Can. Mining & Metall., Bull., v. 53, no. 583, p. 866-872, 5 maps, Nov. 1960.

Advocacy of the self-potential method of geophysical prospecting is sustained by a number of case histories and a thorough discussion of the practical aspects of conducting surveys and interpreting the results obtained.--P. R. Eakins.

3-4104. Toporets, S. A. A METHOD OF STUDYING THE ELECTRICAL PROPERTIES OF FOSSIL COALS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 379-383, 3 figs., 29 refs.

The specific electrical resistivity of ingredients and of coal types diminishes with increase in the degree of metamorphism, this diminution occurring uniformly throughout the whole range of metamorphism and the sharpest change occurring at the boundary between uninflammable coals and anthracites.

The slope of the resistivity-carbonization curve varies in the region of varieties D, G, PZh, K, PS and T in coals from deposits where the type of metamorphism varies: the gradient is steepest for coals from deposits with thermal, and particularly contact metamorphism, least steep for regional metamorphism deposits.

The specific resistivity of bituminous coals has a definite relationship to ash content, although this relationship varies with the degree of metamorphism: in coals of low or medium metamorphism the resistivity falls in indirect ratio to the ash content; in the semianthracites and anthracites it rises in direct ratio to the ash content. The transition point from one relationship to the other is the uninflammable coal stage.

The over-all picture of variation in resistivity as a function of ash content depends directly on the mineralogical composition of the mineral admixtures (ash content). The petrographical composition of the coal influences its specific resistivity less than the degree of metamorphism and the ash content. Coals, being banded, nonhomogeneous media, possess anisotropic electrical conductivity which is always greater than unity and due mainly to the textural character of the coals.

The method of work and the results obtained fully correspond and agree with the data and conclusions produced by a number of authors from chemical, X-ray and other methods of investigating fossil coals. --From auth. concl.

3-4105. Keller, George V., and Frank C. Frischknecht. INDUCTION AND GALVANIC RESISTIVITY STUDIES ON THE ATHABASCA GLACIER, ALBERTA, CANADA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 809-832, 16 figs., Toronto, University of Toronto Press, 1961) 8 refs.

The U.S. Geological Survey has studied the use of electrical methods for measuring ice thickness on the Athabasca Glacier. Two methods for measuring resistivity were tested: one, a conventional resistivity method in which current was fed galvanically into the glacier through electrodes; and the other, an electromagnetic method in which a wire loop laid on the ice

was used to induce current flow. Both the galvanic and the inductive techniques for measuring resistivity were capable of measuring ice thicknesses up to 1,000 ft., the maximum thickness of the Athabasca Glacier. The electromagnetic method appeared to be the better of the 2 for measuring thickness of ice and for measuring the resistivity of the rock beneath the ice, while the galvanic method was better for studying differences within the ice.--Auth.

3-4106. Duvall, Wilbur I. DESIGN CRITERIA FOR PORTABLE SEISMOGRAPHS: U.S. Bur. Mines, Rept. Inv. 5708, 6 p., 2 figs., 1961.

Surface vibrations of ground, rock, and structures resulting from blasting or other sources are often measured with portable seismographs. These instruments are usually supported by a 3-point mount or tripod which is simply placed on a horizontal surface on which vibration levels are to be measured. The rigid-body motion of a tripod-supported seismograph is considered from the point of view that there should be no slippage of the feet with respect to the surface and none of the feet should leave the surface as a result of imparted motion. From these studies the following design criteria are deduced which assure that the seismograph will respond accurately to vibration levels as large as 1/2 g. [g.=acceleration caused by gravity]: 1) the coefficient of friction between the feet and the surface on which the instrument rests should be as large as possible, preferably approaching unity; 2) the center of gravity of the instrument should be vertically above the centroid of the 3-point mount; and 3) the vertical distance between the center of gravity of the instrument and the centroid of the 3 points of contact with the surface should be less than the perpendicular distance between the centroid point and any one of the 3 sides of the triangle formed by the 3 points of contact. Portable seismographs that do not satisfy these conditions should be clamped to the surface if vibration levels above 0.1 g. are to be recorded.--Auth summ.

3-4107. Nile, Stephen W. THE HEBGEN LAKE EARTHQUAKES: De Re Metallica, v. 26, no. 3, p. 2-12, 5 figs., 5 tables, June 1961, 5 refs.

Data on magnitude, intensity, acceleration, epicenter locations, and size of areas affected are given for the Hebgen Lake earthquakes of Aug. 17-19, 1959, and for several other strong quakes which have affected the same general area in the last few decades. An isoseismal map of the Nov. 23, 1947, Montana earthquake reveals both "not felt" islands within the area generally affected and "outliers" of isoseismal contours well outside. A unique aspect of the Hebgen Lake earthquake was the relatively low accelerations it produced.--M. Russell.

3-4108. Panassenko, G.D. THE KOLA PENINSULA EARTHQUAKES OF 2 AND 9 FEBRUARY 1960: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 363-367, 4 figs., 3 tables, 8 refs.

The Kola peninsula is regarded as a low-seismicity area. In Feb. 1960, 2 perceptible earthquakes were noticed, the first it had been possible to register in that area even by instrumental means. The earthquakes are each described in detail. It is concluded that the Feb. 2, 1960, earthquake is a striking example of the fact that the existing network in the northern part of the European Soviet Union is inadequate for studying even relatively high-intensity earthquakes (M = 4.5) in the eastern part of the Baltic shield. To study the seismicity of this region at the requisite level, the single seismic detector station at present located in the area must be supplemented by at least 2 other stations, specifically designed for the study of the weak earthquakes which are fairly frequent there.--L. M. Dane.

3-4109. Buné, V.I. SOME RESULTS OF A DETAILED STUDY OF SEISMIC CONDITIONS IN THE STALINGRAD REGION IN 1955-1959: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 237-242, 6 figs., 4 tables, 22 refs.

This article presents the results of a study of the connection between the foci of earthquakes and the basic fractures, compares the parameters of the seismic conditions determined by short and long observations, and gives a comparison between the maps of seismic activity and maps of the isoseists according to macroseismic data.--Auth.

3-4110. Gaiski, V.N. SOME FEATURES OF THE SEISMIC PROCESS FROM A STUDY OF EARTHQUAKES IN TADZHIKISTAN: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 368-371, 2 figs., 3 tables, 12 refs.

During the Tadzhik multi-purpose seismological expedition, a procedure was developed for the quantitative investigation and mapping of seismic activity. Results that are similar in nature but that vary in their degree of detail are often obtained when analyzing the records of expeditions and of the regional network of seismic stations. The 2 methods of observation are discussed and evaluated. Seismic expeditions produce detailed observations, and the receiving apparatus is highly sensitive. This high quality material can be used in a statistical approach. The main drawbacks of observations of this type are their short duration and the almost total absence of data on comparatively strong earthquakes. Seismic station records contain a large amount of information on comparatively strong earthquakes over a long period but do not normally provide enough sufficiently accurate seismic material. While both types of observations yield the same general results, the detail and accuracy of the one and the comparative duration of the other stress different sides of the same phenomenon.

According to the author, main objects of costly observations should be 1) to study the way in which the properties of weak and strong earthquakes are connected, and 2) to study the seismic process by statistical methods.--L. M. Dane.

3-4111. Bulin, N.K., and others. THE SEISMICITY OF TURKMENIYA AND NORTHEASTERN IRAN IN 1957-1959: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 342-345, 2 figs., table, 22 refs.

Data on 183 earthquakes of Turkmeniya and northeastern Iran in 1957-1959 have been generalized. On the basis of a comparison of the data on the seismicity and the deep geological structure of the territory of Turkmeniya certain connections have been noted in the distribution of the epicenters, and of the structure of the earth's crust: a) it was found that the foci of earthquakes originating on the platform are for the most part related to mobile belts; b) most of the epicenters belong to regions of the earth's crust with a

thickness of 35-40 km. and more. The affinity of a number of earthquakes on the platform for zones of great horizontal gravity gradients was noted.

Weak earthquakes of Turkmeniya and northeastern Iran in 1957-1959 were noted for the most part in regions where there had been strong earthquakes in the past.--Auth. concl.

3-4112. Feofilaktov, V.D. ON INSTRUMENTAL DETERMINATION OF THE ENERGY OF SEISMIC WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 262-265, 4 figs., 3 tables, 2 refs.

During the 6-month period [June-Dec. 1959] of operation of the setup, a number of earthquakes of magnitudes M = 5.5-7.5 and epicentral distances Δ = 20-160° were recorded.

For the major portion of earthquakes the trig - gering of the setup took place with the first arrival. Due to the high sensitivity of the signal, the triggering of the setup often took place due to the microseismic vibrations (50% of all cases of triggering). With the given type of construction of the starting mechanism, we obviously have to accept this fact if we intend to retain the assumed value of the operational threshold.

The results of processing 7 earthquakes recorded in 1959 are tabulated, and a sample of an earthquake energogram is shown.

The numerical values of $\bar{J}_j$, obtained from the seismogram of conventional-type instruments, are always lower than the numerical values of $\bar{J}_j$ obtained from the recordings of an energometer. This was to be expected, even if only because of the fact that for 12-18 sec. periods (surface waves), the frequency characteristic of the conventional-type instruments was not sufficiently accurately known. From this point of view, the energometer possesses an advantage. For body waves, the method of expressing an integral as a sum, is generally inapplicable due to the irregularity of the oscillations in the waves, the general labor-consuming nature, and insufficient accuracy of this method.

The comparisons carried out and the results of the initial functioning of the energometer have demonstrated that the information obtained with its use is obviously most accurate and can be used for geophysical interpretation.--From auth. concl.

3-4113. Monakhov, F.I. FREQUENCY SELECTION OF OCEAN STORM MICROSEISMS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 251-255, 10 figs., 3 refs.

Recent investigations have shown that energy losses from the propagation of microseisms along the ocean bottom are far greater than in the case of continental microseisms. This severely limits the possibilities of using microseisms to trace the passage of cyclones over the ocean. Microseisms originating far from shore become too weak for detection by ordinary seismic stations. The paper gives the results of attempts to isolate such microseisms at continental and island points by means of frequency selection.--Auth.

3-4114. Tolstoy, Ivan. ELASTIC WAVE INTERFEROMETRY - A NEW TOOL: Jour. Geophys. Research, v. 66, no. 8, p. 2485-2488, 6 figs., Aug. 1961, 4 refs.

A harmonic source in a vertically stratified waveguide excites a number of propagating modes, each having its own characteristic wavelength in the horizontal direction. These modes interfere, giving characteristic oscillations of the wave field amplitude as a function of range from the source. It is pointed out that in the case of a 3-layered half-space the interference wavelength Λ of the first 2 modes is very sensitive to layer properties. In particular, if one examines the effect of the second (intermediate) layer, it is seen that this wavelength is most sensitive in that range of parameters for which the usual seismic techniques are mostly inadequate. In principle the method can be used in any properly chosen frequency range for both elastic and liquid media. It also appears that transient wave recordings (explosions, earthquakes, microseisms, etc.,) obtained by a sufficient number of receivers could be filtered to determine Λ and thus to utilize this technique. Tables providing sufficient coverage for a large variety of model types would not be difficult to calculate by means of currently available computing machinery.--Auth.

3-4115. Riznichenko, Yu. V., and others. ELASTIC WAVES WITH GENERALIZED VELOCITY IN TWO-DIMENSIONAL BIMORPHIC MODELS: Akad, Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 321-334, 16 figs., 2 tables, 24 refs.

Formulas are derived for the propagation velocities of long longitudinal and transverse waves in thin bimorphic and polymorphic plates in 2-dimensional modeling of seismic waves. As a result of experiments carried out, the formation process of waves with a generalized velocity has been investigated, and the field of application of the long-wave theory has been evaluated. A bimorphic model of a gradient medium has been designed and constructed by which the amplitude characteristics of the longitudinal waves have been investigated.--Auth.

3-4116. Podyapolsky, G.S. REFRACTION AND REFLECTION INDICES FOR AN ELASTIC WAVE AT A LAYER: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 335-341, 7 refs.

Formulas for the numerical calculation of the refraction and reflection indices of elastic waves at a layer of constant thickness are obtained. These formulas are given in particular, in terms of the refraction and reflection coefficients at the boundaries of the layer. These coefficients are treated as operators that transform the waveforms and their frequency patterns. Certain limiting cases are considered.--Auth.

3-4117. Bates, Charles C. VELA UNIFORM, THE NATION'S QUEST FOR BETTER DETECTION OF UNDERGROUND NUCLEAR EXPLOSIONS: Geophysics, v. 26, no. 4, p. 499-507, 7 tables, Aug. 1961.

One of the major problems in reaching an agreement on a treaty to cease nuclear weapons' testing has been the lack of an effective control system to police such a ban. This paper provides a resumé of key technical events that have occurred with reference to the creation of such a control system, capable of detecting and identifying underground nuclear explosions. The paper also describes the VELA UNIFORM program, a widespread research and development effort under the over-all management of

the Advanced Research Projects Agency, that is designed to improve markedly the state of the art in this particular technical field over the next 2 or 3 years.--From auth., p. 499.

3-4118. Van Melle, F. A. NOTES ON THE SESSION ON GOVERNMENT SCIENCE AT THE SEG CONVENTION IN GALVESTON, TEXAS, NOVEMBER 1960: Geophysics, v. 26, no. 4, p. 508-513, Aug. 1961.

The history of the attempts at seismic control of nuclear tests shows that even before the discovery of decoupling or muffling - known in seismic exploration from shooting in a dry cavity - of explosions, the state of the art favored the cheating nation. With muffling, detection lags concealment of small nuclear tests by a factor in excess of 100.

Technical and political considerations cannot be separated. A multibillion dollar effort such as the 180 seismic-station Geneva system should not be undertaken without virtual certainty of adequate detection. If delays in construction, operation, and in situ inspection rendered the program ineffective within Russia and China after the free world had spent billions on the network in other parts of the world, the West would have suffered a sensitive cold war defeat and incurred the resentment of the underdeveloped nations. It would face frustration and loss of confidence at home. A fraction of the number of Geneva stations within the U.S.S.R., supplemented by a world-wide net of seismological observatories of universities and other bodies with standard modern equipment and exchange of personnel and data, would have all the indirect advantages claimed by Dr. H. Bethe for the full Geneva system.

A break-through in research to advance detection by a factor in excess of 100 is needed before an effort of DEW line magnitude appears justified. The probability of radical break-throughs in research is never large. This diminishes the importance of attempts to improve detection by factors of 2 or 3 and of auxiliary development projects, such as those connected with on-site inspection which presuppose effective seismic detection by a world-wide net of stations.--Auth.

3-4119. Knudsen, William C. ELIMINATION OF SECONDARY PRESSURE PULSES IN OFFSHORE EXPLORATION: Geophysics, v. 26, no. 4, p. 425-436, 9 figs., 2 tables, Aug. 1961, 13 refs.

The behavior of a gas bubble generated by detonating an explosive below the surface of the ocean and located centrally in a perforated sphere, perforated pipe, and solid-walled pipe has been studied by means of a scale model. The motion of the bubble was recorded using a high speed camera, and the pressure variations were recorded using a small pressure detector. The behavior of the gas bubble when surrounded by a perforated sphere has also been analyzed numerically. The model results showed that significant reduction in secondary pressure pulse amplitude was effected by all 3 devices, but the perforated sphere was the most effective. That enclosing the gas bubble in a perforated sphere would effectively eliminate the secondary pressure pulses was also verified by the numerical solution of the motion. Design criteria for a perforated sphere are presented. --Auth.

3-4120. Hunkins, Kenneth L. SEISMIC STUDIES OF THE ARCTIC OCEAN FLOOR (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 645-665, 17 figs., Toronto, University of Toronto Press, 1961) 9 refs.

Reflection and refraction seismic measurements from drifting station Alpha in the Arctic Ocean revealed details of a prominent submarine rise, called the Alpha rise. This rise trends across the Arctic Ocean subparallel to the Lomonosov ridge. The minimum depth sounded in its central portion was 1,426 m. at 85°03'N. and 171°00'W. The rise descends to depths of over 3,000 m. to the N. and S. Sub-bottom reflections revealed a characteristic echo from a depth of several hundred meters below the ocean floor in the eastern area of the rise. This reflection was not pronounced in the western area. The eastern area also had a rougher bottom texture than the western area.

Several short unreversed refraction profiles were made. Dips and strikes of the ocean floor from reflection records aided interpretation. An average of 3 measurements showed the upper "unconsolidated" layer to be 0.38 km. thick. One profile revealed a 2.80 km. thick layer of 4.70 km./sec. velocity. Below this lay the "oceanic" layer with a velocity of 6.44 km./sec. and an undetermined thickness.--Auth.

3-4121. Roethlisberger, Hans. SEISMIC REFRACTION SOUNDINGS IN PERMAFROST NEAR THULE, GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 970-980, 6 figs., table, Toronto, University of Toronto Press, 1961) 6 refs.

The applicability of various seismic methods for engineering purposes has been investigated in the Thule area. Special attention has been given to the refraction method in the cases where shallow ice (up to 200 ft.) occurs overlying frozen ground (till), or where frozen ground (till, outwash) up to a few hundred feet thick overlies bedrock. Seismic velocities have been measured in different types of sediments of the Thule formation and in the crystalline basement rock. Very high velocities were found for all types of rock; the temperature was about -10°C., and most pores and cavities were probably filled with ice. It was discovered that for shallow soundings of a few hundred feet, the seismic methods can probably be used more elaborately in permafrost than in unfrozen material, as later pulses can be identified on the records shortly after first breaks. A negative velocity gradient in frozen ground is believed to be responsible for this. --Auth.

3-4122. Meador, Jimmie G. MARINE SEISMOGRAPH AND SPARKER SURVEY IN THE MACKENZIE RIVER, NORTHWEST TERRITORIES (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1153-1156, 2 figs., Toronto, University of Toronto Press, 1961) 2 refs.

The Mackenzie River, Northwest Territories, flows from Great Slave Lake northward 1,000 m. to the Arctic Ocean with an average gradient of half a foot per mile. The sediments range in age from Pleistocene drift to Paleozoic.

A Sparker traverse of the Mackenzie River starting at Hay River was carried out down to the Sans Sault Rapids, a distance of 650 mi. The Sparker instrument recorded seismic reflections from the river bottom, and from 1 to 3 sub-bottom horizons to a depth of 400-1,600 ft. in a continuous profile. At a rate of 40 mi. per day the Sparker recorded the geologic configurations every 3 ft. of the near-surface formations, giving an accurate recon-

naissance of the area.

In addition, a marine seismic survey was conducted in selected areas at a rate of 70 shot locations per day, mapping the geologic horizons down to basement.

Sparker and marine seismic were used to detail the Norman Wells reef oil field beneath the Mackenzie River. These data may be used as references to correlate reflections with other data recorded.--Auth.

3-4123. Layat, C., and others. SOME TECHNICAL ASPECTS OF REFRACTION SEISMIC PROSPECTING IN THE SAHARA: Geophysics, v. 26, no. 4, p. 437-446, 9 figs., Aug. 1961, 6 refs.

The refraction method of seismic exploration was initiated in 1952 in the northern Sahara after several difficulties were encountered with the reflection method. The first tests showed the existence of a deeper marker bed having a velocity of about 6,000 m./sec.(20,000 ft./sec.) which later proved to be the eroded surface of the basement. Now refraction can be employed, at least in certain regions, in detailed surveys although many difficulties in interpretation still exist.

Both field practices and methods of interpretation are discussed.--Auth.

3-4124. Savinsky, I.D. ON THE SOLUTION OF THE INVERSE PROBLEM IN γ-RAY MEASUREMENTS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 243-246, 2 figs., 2 refs.

The problem of using γ-ray measurements to determine the density distribution of radioactive sources is discussed. A method is proposed for investigating possible ways of solving this inverse problem. The method is applicable in principle to practically any distribution of radioactive matter.--Auth.

3-4125. Bulashevich, Yu.P., and I.N. Senko-Bulatny. EXPERIMENTAL VERIFICATION OF OPTIMUM CONDITIONS FOR CONTINUOUS [SIC] NEUTRON LOGGING: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 4, p. 345-348, 4 figs., 2 refs.

Basic propositions in the theory of continuous neutron logging were experimentally verified. The experimental and theoretical data in connection with neutron logging in Mesozoic bauxite deposits were found to be in good agreement. Greater precision was achieved in the quantitative theoretical relationships. Practical recommendations for continuous neutron logging are given.--Auth.

3-4126. MacDonald, Gordon J.F. SURFACE HEAT FLOW FROM A DIFFERENTIATED EARTH: Jour. Geophys. Research, v. 66, no. 8, p. 2489-2493, 12 figs., 2 tables, Aug. 1961, 5 refs.

Numerical calculations have been carried out on the development of surface heat flow in model earths. The bulk radioactivity of the earth is taken equal to that of chondritic meteorites. The initial temperature reaches 2,600° at 1,200 km. The heat flow for a model in which the radioactivity is uniformly distributed in the outer 600 km. is 90 ergs/cm.^{2}/sec. If the radioactivity is concentrated in the outer 100 km., the present-day surface heat flow is 68 ergs/cm.^{2}/sec. The initial heat contributes about one-fifth the surface heat flow. The examination of the relations between initial heat, radioactive distribution, and heat flow suggests that if the earth has the radioactive composition of chondritic meteorites, then a near-surface concentration of heat sources must have proceeded at temperatures well below the melting point of silicates. Radioactivity lower by a factor of 2 would remove the indicated discrepancies.--Auth.

3-4127. Kraskovsky, S.A. ON THE THERMAL FIELD IN OLD SHIELDS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 3, p. 247-250, 4 tables, 24 refs.

Geothermal investigations in shield areas lead to the following general conclusions. The geothermal gradient is rather low and the heat flow is rather small. The average geothermal gradient in shields is equal to 1.2°/100 m. and the average heat flow is equal to 0.87 x 10^{-6} cal.cm.$^{-2}$ sec.$^{-1}$. The above features of the thermal field of shields are explained in a general fashion by the observation that the heat conductivity of the rocks of which shields consist, and which are very dense, is rather high.--Auth.

3-4128. Plouff, Donald, and others. GEOPHYSICAL STUDIES ON IGY DRIFTING STATION BRAVO, T-3, 1958 TO 1959 (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 709-716, 9 figs., Toronto, University of Toronto Press, 1961) 4 refs.

During 1958 and 1959, the U.S. Geological Survey conducted geophysical investigations on Ice Island T-3 while it was drifting southwestward along the arctic coast of Canada. The water depths ranged from 200 to 2,500 m., as determined by seismic measurements. Below 200 m. the sea water has a uniform electrical resistivity of approximately 0.30 ohm-meters and from the surface down to 200 m., the resistivity decreases from 0.40 to 0.30 ohm-meters. An electromagnetic profile across the center of Ice Island T-3 indicated an approximately uniform ice thickness of about 60 m.--Auth.

3-4129. Cromie, William J. PRELIMINARY RESULTS OF INVESTIGATIONS ON ARCTIC DRIFT STATION CHARLIE (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 690-708, 14 figs., Toronto, University of Toronto Press, 1961) 10 refs.

Station Charlie, established on the pack ice of the Arctic basin, drifted in an E.-W. line across a shallow peninsula of the Chuckchi shelf during July and Aug. 1959. Continuous soundings were taken within an accuracy of 1 m. across the feature and in adjacent deep water. A bathymetric profile has been constructed and the angles of slope computed from seismic reflections.

Twenty-two piston cores were taken, ranging in penetration to 250 cm. Over 100 bottom photographs, made on the peninsula and in deep water, show rocks and an abundance of life. Six trawls brought to the surface geological and biological specimens. An attempt at dating by radiocarbon analysis of pelagic forams is in process.

In addition to investigations in submarine geology and biology, work in seismology and magnetics was done. Reflection techniques were used for determinations of dip and strike of bottom sediments.

Studies were made of long range sound transmission by seismic means. Both relative and continuous absolute values of the magnetic field were measured. Records were taken during a magnetic storm and solar flare disturbance.

A vertical seismometer was installed on the pack ice and successfully recorded at least one earthquake. Small variations in atmospheric pressure were recorded continuously on a microvariobarograph. --Auth.

3-4130. Pemberton, Roger H. "TARGET MATTAGAMI": Can. Mining & Metall. Bull., v. 54, no. 585, p. 22-29, 12 figs., Jan. 1961.

The Mattagami district of Quebec has experienced intense and detailed geological and geophysical surveying, followed by drilling of nearly all possible bets. As a result, a number of well-mineralized Zn-Cu bearing bodies have been found. Considering only the airborne geophysical surveying, some blocks of ground have been flown by almost every geophysical instrument which has to date been installed in an aircraft, including various types of magnetometers, electromagnetometers, and scintillation counters. Ground operations are briefly described, then electromagnetic prospecting by helicopter. Geophysical results are presented for various mining properties.

Effectiveness of all the various techniques and systems cannot yet be evaluated fully as active exploration is still going on. Some facts have been established: 1) all discoveries made to date have been a direct result of geophysical surveys; 2) employment of the magnetic method, both in the air and on the ground proved to be extremely useful, as all sulfide ore bodies found have been associated with magnetite and/or pyrrhotite; 3) employment of the Sikorsky S-55 helicopter with its in-phase and out-of-phase EM instrumentation and the total field magnetometer, provided extremely good data; the per line mile costs for this data were less than one-quarter the cost of equivalent ground surveys.--A.C. Sangree.

3-4131. Schmeck, Harold M., Jr. GULF IS REPORTED ONCE A 'DEAD SEA': New York Times, v. 111, no. 37,872, p. 33, col. 1., illus., Oct. 2, 1961.

The presence of salt-dome structures on the floor of the Gulf of Mexico indicates it was once a landlocked basin. The structures are located within a 50-by-100-mi. area centered at 24°N. 92°W. and were detected by a newly perfected continuous-profile geophysical method employed on the oceanographic research vessel Vema.--M. Russell.

7. GEOCHEMISTRY

See also: Mineralogy 3-4161; Mineral Deposits 3-4235; Fuels 3-4258.

3-4132. Daniels, Farrington. KINETICS AND THERMOLUMINESCENCE IN GEOCHEMISTRY: Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 65-74, table, March 1961, 20 refs.

A brief survey of applications of physical chemistry in geochemistry is given, including thermodynamics and kinetics, electrochemistry, adsorption, and radiation damage. Among the newer techniques are shadow photographs with soft X-rays, neutron activation, solar furnaces, differential thermal analysis, and infrared absorption spectroscopy.

Labratory studies of the formation of calcite and aragonite suggest that Sr plays an important part in the formation of aragonite.

Thermoluminescence of crystals refers to the light given off by release of electrons from imperfections in the crystal lattice on heating. This effect may be caused by pressure, impurities, missing anions and by high energy radiation. Based on the latter mechanism methods for dating limestones, pottery, and a number of geological materials have been worked out.--F. Manheim.

3-4133, Kretz, Ralph. SOME APPLICATIONS OF THERMODYNAMICS TO COEXISTING MINERALS OF VARIABLE COMPOSITION. EXAMPLES: ORTHOPYROXENE-CLINOPYROXENE AND ORTHOPYROXENE-GARNET: Jour. Geology, v. 69, no. 4, p. 361-387, 15 figs., 5 tables, July 1961, 36 refs.

Consideration is given to the relationship between the chemical potential of a species and its concentration in solids of the type (A, B, C)M and (A, B)(C, D)$_q$ M, where A, B, C, D, and M are chemical species. On this basis the distribution coefficient is derived for different combinations of chemical mixtures. For coexisting phases α = (A, B)M, and β = (A, B)N, the distribution coefficient with reference to species A is

$$K_D = \frac{X_A^{\alpha}(1 - X_A^{\beta})}{(1 - X_A^{\alpha})X_A^{\beta}} = \frac{f_B^{\alpha} f_A^{\beta} \lambda_B^{BM} \lambda_A^{AN}}{f_A^{\alpha} f_B^{\beta} \lambda_A^{AM} \lambda_B^{BN}},$$

where X = A/(A+B), the terms in f denote activity coefficients, and the terms in λ denote absolute activities. For coexisting phases α = (A, B, C)M and β = (A, B, C)N the distribution coefficient with reference to A has a similar form and is now dependent on the B:C ratio in either phase.

The pressure dependence and temperature dependence of the distribution coefficient can be expressed by the equations:

$$K_{D2} = K_{D1} \exp\left[\frac{(-V_A^{\alpha} + V_B^{\alpha} + V_A^{\beta} - V_B^{\beta})(P_2 - P_1)}{RT}\right],$$

and

$$K_{D2} = K_{D1} \exp\left[\frac{(H_A^{\alpha} - H_B^{\alpha} - H_A^{\beta} + H_B^{\beta})\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}{R}\right],$$

where P = pressure, T = absolute temperature, R is the gas constant, and the terms in V denote partial molar volumes and those in H, partial molar enthalpies.

The coexistence of natural orthopyroxene and clinopyroxene is considered as an example of 2 phases of the type (A, B)M and (A, B)N. K_D is evidently independent of X, indicating that both phases are ideal mixtures. In rocks of presumed metamorphic crystallization, $K_D \simeq 0.54$ and in rocks of presumed igneous crystallization, $K_D \simeq 0.73$. The difference in K_D is attributed to a difference in crystallization temperature.

The coexistence of natural orthopyroxene and garent is considered as an example of 2 phases of the

type (A, B, C, D)M and (A, B, C, D)N. With reference to Mg, K_D is correlative with the Mn-concentration in garnet. This relationship provides empirical confirmation of the chemical theory.--Auth.

3-4134. MacChesney, J. B., and Arnulf Muan. PHASE EQUILIBRIA AT LIQUIDUS TEMPERATURES IN THE SYSTEM IRON OXIDE-TITANIUM OXIDE AT LOW OXYGEN PRESSURES: Am. Mineralogist, v. 46, no. 5/6, p. 572-582, 4 figs., May-June 1961, 24 refs.

Phase relations in the system iron oxide-titanium oxide were determined by heating oxide mixtures at O pressures defined by the Fe-wüstite equilibrium. The mixtures were either heated in Fe crucibles in a N atmosphere, or enclosed in sealed vitreous-silica tubes together with an Fe-wüstite buffer. Compositions of mixtures prepared under these conditions were found to deviate somewhat from those of the join FeO-TiO_2. Mixtures of high Fe content contained some Fe^{3+}, whereas mixtures of high titanium oxide content contained some Ti of valence states below +4.--Auth.

3-4135. Morey, George W., and Robert O. Fournier. THE DECOMPOSITION OF MICROCLINE, ALBITE AND NEPHELINE IN HOT WATER: Am. Mineralogist, v. 46, no. 5/6, p. 688-699, 2 figs., 4 tables, May-June 1961, 4 refs.

The decomposition of microcline, albite, and K-bearing nepheline was investigated by slowly pumping distilled water at 295°C. and 2,500 p.s.i. over each sample for 135 days. The liquids collected from the bombs were analyzed for Na_2O, K_2O, Al_2O_3, and SiO_2. Microcline was partially decomposed to muscovite. The total amount of material in solution averaged 167 p.p.m., and the pH averaged 7.9. Albite partially altered to boehmite, paragonite, and an amorphous material. The total amount of material in solution averaged 243 p.p.m. and the pH averaged 7.9. An alteration profile was found in the nepheline sample container. Mainly muscovite plus minor analcite were found at the exit end of the container while mainly boehmite was found at the entrance end. The total amount of material in solution averaged 440 p.p.m. and the pH averaged 9.7 with a high of 10.2. The ratio of Na to K in the solutions leached from each of the minerals was greater than the ratio of Na to K in the starting material.--Auth.

3-4136. Laevastu, Taivo, and Otto Mellis. SIZE AND MASS DISTRIBUTION OF COSMIC DUST: Jour. Geophys. Research, v. 66, no. 8, p. 2507-2508, fig., Aug. 1961, 6 refs.

The size distribution of the cosmic spherules found in sediments shows that the total mass of particles in equal size (diameter) intervals remains constant. The size distribution of cosmic dust in space, as computed from the data obtained by impact measurements by artificial satellites, shows the same distribution in the interval of particle diameters approximately 5μ and 15μ, and as determined by indirect extrapolation the distribution is probably valid for larger particles.--Auth.

3-4137. Vinogradov, A. P. METEORITES AND THE EARTH'S CRUST: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 3-24, 8 figs., 22 tables, pub. 1961, 32 refs.

Data on the distribution in igneous rocks and meteorites of rare elements and isotopes of O, S, and C, as well as zonal fusion of the silicate fraction of chondrites and other silicates could help in determining the origin of different types of meteorites in contrast to that of igneous rocks of the earth.

Stony meteorites comprise chondrites and achondrites. An average of 12% metallic Fe and 6% troilite are contained in a chondrite mass as separate grains. The several varieties of chondrites consist of olivine and enstatite, bronzite, or hypersthene with only slight variations of ratio in various types.

The achondrites are nonfeldspathic and feldspathic. The chemical composition of the silicate phase of nonfeldspathic achondrites, in comparison with that of chondrites, differs by a higher content of SiO_2 (and MgO) and a lower content of Al_2O_3, CaO, TiO_2, and alkalies. Feldspathic achondrites usually contain anorthite and in all respects correspond more closely than others to diabase.

Of stony meteorites found on earth, chondrites are most numerous. In these the relation of Ni content in the Fe phase and the iron oxide in the silicate phase follows the so-called "Prior rule." Meteorites, particularly stony ones, being porous bodies of low density, could have evolved only in weak gravitational fields.

The distribution of rare elements may be correlated with the presence and amount of SiO_2 in igneous rocks. In Fe-stony meteorites, the K content in olivine is as low as 1×10^{-3}%, a low K content encountered in ultrabasic rocks, particularly in dunites. Stony meteorties contain much smaller amounts of terrestrial rare elements than do igneous rocks. Dunites contain most rare elements by at least 1/2 to 1 order lower than achondrites, and therefore dunites are considered to be residual rocks from the fusing out of the light fraction from the material corresponding in composition to chondrites.

The isotopic ratio in a number of chemical elements points to the conditions of their origin and first of all to the temperature of formation and to the oxidizing character of the environment. The isotopic ratios of S, O, and C, are similar for all types of meteorites. In isotopic ratios of light elements, the dunites, more than other rocks, resemble meteorites (chondrites).

The formation of meteorites occurred in regenerative conditions, at higher temperatures than those prevailing in the process of magmatic differentiation on earth. Zonal fusion studies show that at the incongruent temperature of fusion of $MgSiO_3$ from chondrites, one can expect the fusing out of approximately 7% SiO_2. Before the incongruent melting point of $MgSiO_3$ was reached, few sublimates were formed. At the moment of incongruent fusion, approximately 1,600°C., there was a considerable amount of volatile sublimates including the main mass of K, U, and other elements.

Assuming that the earth's mantle was composed of a substance similar in content to chondrites, and that the earth's crust was formed by the fusing-out and degassing of the mantle in a way analogous to zonal fusion, the thickness of the crust will depend on the radius of the planet. The maximum possible thickness of the crust may reach 7% the thickness of the mantle.

In differentiation of meteoritic material the existence of 2 different processes are assumed, the first leads to formation of Fe-stony meteorites, and the other to all remaining types of stony meteorites, the achondrites.

Formation of zones of sufficient thickness with high gradients of concentration of fusible and volatile aggregates similar to the earth's crust, depends on the

radius of the planet or other body.

Two fundamental processes are distinguishable in the formation of meteorites: 1) mixing, agglomeration of silicate chondrules and Fe masses as well as of troilite, in the formation of chondrites, Fe-stony, and stony meteorites; and 2) formation of achondrites from chondrites on bodies of small size, with the result that volatile aggregates are not present in sufficient amounts, or are actually lost.--J. W. Skehan.

3-4138. Heier, K. S. ESTIMATION OF CHEMICAL COMPOSITION OF ROCKS: Am. Mineralogist, v. 46, no. 5/6, p. 728-733, 5 tables, May-June 1961, 5 refs.

In the calculation of chemical composition, the mineral percentages computed from the thin-section must be reliable. Analyzed and calculated compositions are closer for quartz-feldspathic rocks than for ferromagnesian rocks. It is difficult to derive the chemical composition of ferromagnesian minerals by optical means alone. Example analysis and calculations are presented and discussed.--K. A. Riggs.

3-4139. Yakushevskaya, I. V. MICROELEMENT CONTENT IN CERTAIN SOILS OF THE VLADIMIR REGION: Pochvovedeniye, Soviet Soil Sci., in translation, 1960, no. 6, p. 653-657, 6 tables, pub. 1961, 5 refs.

The microelement content was determined in dark gray forest, dark meadow, and dark meadow gley soils in the Vladimir region. All the soils studied contain enhanced amounts of Cu, Ti, and Mn, and reduced amounts of Co and Cr. The quantity of Ni, Pb, and V is approximately the same as in chernozems (average content of microelements in thick chernozems was taken as the standard). There is slightly more V than Cr, which is the reverse of the normal.

The common features of the microelement composition of the soils studied are due to the uniformity of parent materials, the nearness of the soil profiles, and the genetic link of the soils. Differences in content and distribution are due to features in the soil-forming process. These differences are revealed both in the geomorphological profile and in the distribution of microelements throughout the genetic horizons.

Biogenic accumulation of Ni and Cu is clearly shown. Ti, Mn, V, Cr, and Pb are fairly evenly distributed throughout the geomorphological profile. Ti, Mn, and Pb predominate slightly in gray forest soils. This is associated with considerable Mn accumulation in leaves and needles and, therefore, in the humus horizons of forest soils. No conclusions can be drawn for variations of Co.--F. R. Hall.

3-4140. Silvey, William D. CONCENTRATION METHOD FOR THE SPECTROCHEMICAL DETERMINATION OF MINOR ELEMENTS IN WATER: U.S. Geol. Survey, Water-Supply Paper 1540-B, p. 11-22, fig., 7 tables, 1961, 16 refs.

A combined chemical and spectrographic method is described, in which traces (1.0-0.005 mg.) of Cu, Pb, Mn, Al, Cr, Zn, and Fe are quantitatively determined in water samples.

The method of Heggan and Strock was modified to obtain more effective buffering in the arcing mixture. The lack of effective buffering in the arcing mixture of the original method resulted in poor analytical results. In the method presented the concentration of In was increased from 10 to 20% in the arcing mixture. This changed the average percent deviation for a single determination from $\pm 64\%$ to $\pm 19\%$ in a wide range of synthetic samples analyzed.

The chemical procedure involves the concentration of the trace metals through the use of selected chelating reagents. The chemical procedure was found to be highly effective in recovering as little as 0.005 mg. of Cu, Fe, Mn, Al, Pb, Cr, and Zn.--Auth.

3-4141. Cook, A. C. THE CARBON ISOTOPIC COMPOSITIONS OF CERTAIN MARINE INVERTEBRATES AND COALS FROM THE AUSTRALIAN PERMIAN: Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 289-290, table, March 1961, 3 refs.

The author does not agree with Compston that no correlation can be demonstrated between the C isotopic composition of certain Australian coals and their rank. Since Compston did not isolate the fundamental microscopic components of coals, the macerals, his conclusion is regarded as insufficiently justified.

To separate the effects of rank and maceral composition it would be necessary to test both samples of individual macerals from one occurrence of a seam and samples from various localities having different rank.--F. Manheim.

3-4142. Park, R., and H. N. Dunning. STABLE CARBON ISOTOPE STUDIES OF CRUDE OILS AND THEIR PORPHYRIN AGGREGATES: Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 99-105, fig., 2 tables, March 1961, 20 refs.

A review of the C isotope relationships between crude oils, porphyrins, and parent organic matter of oils. New data bearing on this question were obtained from analyses of porphyrin concentrates and their host crude oils; checks were carried out on the isotopic fractionation caused by the purification techniques.

C isotope measurements on the porphyrins showed C^{13}/C^{12} ratios 4 to 5 per mil greater than those of the crude oils from which they were extracted. These data indicate that the porphyrins in question were present during the formation and diagenesis of the oil and were not formed from the petroleum hydrocarbon by bacterial action.--F. Manheim.

3-4143. Stern, Thomas W., and Harry J. Rose, Jr. NEW RESULTS FROM LEAD-ALPHA AGE MEASUREMENTS: Am. Mineralogist, v. 46, no. 5/6, p. 606-612, 3 tables, May-June 1961, 12 refs.

Improvement in the spectrochemical method for determining Pb in zircon increases the usefulness of the Pb-alpha (Larsen) age method. Good agreement is found between the Pb-alpha ages and those obtained by isotope dilution analyses on 12 samples. These samples have calculated ages ranging from 400 to 1,200 million years. New Pb analyses and revised Pb-alpha ages are presented for 19 samples previously analyzed.--Auth.

3-4144. Clayton, Robert N., and Samuel Epstein. THE USE OF OXYGEN ISOTOPES IN HIGH-TEMPERATURE GEOLOGICAL THERMOMETRY: Jour. Geology, v. 69, no. 4, p. 447-452, 2 figs., 2 tables, July 1961, 8 refs.

Recent measurements on the O isotopic fractionation between calcite and water and the O isotope measurements on coexisting minerals permit the estimation of the isotopic fractionation factor as a function of

temperature for systems involving any pair of the phases: quartz, calcite, hematite, and water. The use of these calibration curves for geological thermometry is illustrated for several natural samples. The isotopic composition of O in hydrothermal fluids is also estimated from the measured O^{18}/O^{16} ratios in hydrothermal minerals. The mean value thus estimated is 6‰ greater than the O of mean ocean water.--Auth.

3-4145. Ermakov, N. P., and V. A. Kalyuzhnyy. THE POSSIBILITY OF DETERMINING TRUE TEMPERATURES OF MINERAL-FORMING SOLUTIONS. Translated by Vitaut Kipel: Internat. Geology Rev., v. 3, no. 8, p. 706-711, 3 figs., Aug. 1961, 12 refs.

The development and application of thermometric analysis of liquid inclusions in minerals has reached an advanced stage, but so many conflicting reports have been made that a state-of-its-art review is needed. Current capabilities and limitations of the method are outlined.--M. Russell.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Igneous and Metamorphic Petrology 3-4182, 3-4187.

3-4146. Craig, D. B. THE BENFORD PLATE: Am. Mineralogist, v. 46, no. 5/6, p. 757-758, fig., May-June 1961.

A substage mica plate is used in conjunction with the conventional mica plate as an aid in the study of interference figures. The purpose is to eliminate the isogyres and reduce the optic axis to a dark spot. The color rings are not affected.--K. A. Riggs.

3-4147. Larochelle, A. DESIGN OF A CURIE POINT METER: Canada, Bull. 69, 18p., 7 figs., pl., table, 1961, 15 refs.

The Curie point of a substance is defined as the temperature at which that substance abruptly loses its spontaneous magnetization upon being heated. This property depends only upon the chemical composition of a ferromagnetic substance and it may thus be used to identify the members of ferromagnetic solid solution series found in rocks.

The instrument described is of the torsion-balance type, using a photoelectric recording mechanism. Details of the various components of the instrument and an outline of its calibration are discussed.

An attempt was made to confirm the idea that 2 distinct ferromagnetic minerals were present in a suite of igneous rocks. It was concluded that only 1 such mineral was present, or if there were 2, both had the same Curie point.--Auth.

3-4148. Meyrowitz, Robert, and Harold Westley. THE STABILITY OF THE ARSENIC TRIBROMIDE IMMERSION LIQUIDS DURING STORAGE: Am. Mineralogist, v. 46, no. 5/6, p. 761-762, table, May-June 1961, ref.

A set of liquids in clear glass bottles was stored in a dark cupboard for 10 years. The bottles were opened only a few times. The measurements were made at the end of 6 months, 9 months, and 10 years. The change in indices (Δn) ranged from (-0.004) to (+0.002). Some liquids changed color, developed a slight turbidity, or formed a fine precipitate. However, large crystals did not develop, and at the end of 10 years the liquids were still transparent and ready for use.--K. A. Riggs.

3-4149. Mertie, John B., Jr. ANALYTIC CLASSIFICATION AND QUADRIPLANAR CHARTING OF ANALYSES WITH NINE OR MORE COMPONENTS: Am. Mineralogist, v. 46, no. 5/6, p. 613-628, 2 figs., 2 tables, May-June 1961, 17 refs.

Analytic methods are used for the classification of analyses having 9 or more components, though under favorable conditions such analyses may also be charted. A square matrix of the third order is formulated with 3 columns that represent 3-dimensional Cartesian vectors extending outward from the origin. The end points of these vectors are triads of coordinates defined by the percentages of a given analysis. By means of a collineatory transformation, such a matrix is transformed to a new frame of reference wherein these vectors appear as intercepts on new axes of X, Y, and Z. Thus 9 numbers are reduced to 3 unique numerical indices.

The algebraic procedure required for a collineatory transformation consists in the solution of a cubic equation derived from the determinant of a characteristic matrix. The roots of this equation, known as characteristic roots, latent roots, or eigenvalues, are found to be the elements in the principal diagonal of a diagonalized matrix, whose other elements are zeros. The sum of these roots is called the trace or spectrum (T) of the transformed matrix. If the roots are real numbers, their 3 values together with (100-T) may be taken as quadriplanar coordinates for charting inside or outside a tetrahedron of reference. Thus each analysis may be represented by a single point, which may then be projected either apically or orthogonally onto one or more of the triangular faces of the tetrahedron, for a 2-dimensional representation. Complex roots cannot be charted, but the analyses of most igneous rocks yield real roots.

A refinement of this method by the use of symmetrical matrices eliminates complex roots, and thus renders charting universally feasible. Symmetry with respect to the principal diagonal is produced before diagonalization by post-multiplying an unsymmetrical matrix of the third order by its transpose. A generalization of this operation consists in post-multiplying a rectangular array of the order 3x4, 3x5, 3x6, or in general 3x(3+k) by its transpose. This constitutes a third method which provides for the classification and charting of 12, 15, 18, or in general 9+3k variables; and if 1 or 2 zeros are introduced into the rectangular arrays, any number of variables in excess of 9 may be analyzed. The insertion of 1 to 4 zeros in a square matrix of the third order, before it is multiplied by its transpose, makes it possible to handle 8, 7, 6, or 5 variables. These 3 methods are not interchangeable; instead one is selected and used for the required purpose.--Auth.

3-4150. Broch, Olaf Anton. QUICK IDENTIFICATION OF POTASH FELDSPAR, PLAGIOCLASE, AND QUARTZ FOR QUANTITATIVE THIN SECTION ANALYSIS: Am. Mineralogist, v. 46, no. 5/6, p. 752-753, May-June 1961, 2 refs.

A modification of hydrogen fluoride etching is described for distinguishing between untwinned plagioclase and quartz in granitic rocks.

The uncovered thin section is examined by reflected light. The etched plagioclase appears grayish-white whereas the quartz is dark gray. K feldspar is strongly greenish-yellow. Under transmitted light the plagioclase is darker than the quartz. Using this procedure a quantitative determination can be made with a point counter.--K. A. Riggs.

3-4151. Hawes, Lorin. THE DIRECT DETERMINATION OF HEXAGONAL LATTICE PARAMETERS: Am. Mineralogist, v. 46, no. 5/6, p. 763, May-June 1961, ref.

The author has previously explained how to determine lattice parameters of cubic, tetragonal, and orthorhombic crystals directly. The tetragonal case can be extended to hexagonal crystals when ($\alpha=h^2+hk+k^2$).--K. A. Riggs.

3-4152. Denning, Reynolds M. LAMELLAR STRUCTURE IN A TYPE I DIAMOND: Am. Mineralogist, v. 46, no. 5/6, p. 740-743, fig., May-June 1961, 4 refs.

A pale-yellow diamond crystal was selected for a stress optical study. A lamellar structure becomes visible between crossed polars. The lamellae are alternately length slow and length fast. Twinning is absent, but the scattering of X-rays is not uniformly distributed. The region of greatest double refraction scatters X-rays twice as much as isotropic areas. Ultraviolet and infrared absorption characteristics are normal. The most fluorescent portions have the strongest double refraction. Under compression the lamellar birefringence disappeared. Stresses did not affect the diffraction pattern or fluorescence. Apparently a cyclical variation of minor constituents resulted when the diamond crystal grew under periodically varying conditions.--K. A. Riggs.

3-4153. Pabst, Adolf. X-RAY CRYSTALLOGRAPHY OF DAVIDITE: Am. Mineralogist, v. 46, no. 5/6, p. 700-718, 6 figs., 4 tables, May-June 1961, 26 refs.

Partly or wholly metamict davidite from Pima County, Arizona, and from Iveland, Norway, has been reconstituted to single crystals or twins by heating in air. The cell dimensions are a_o 10.37±0.02, c_o 20.87±0.02 Å. The space group is $R\bar{3}$ or $R3$. The suggested ideal content for the rhombohedral cell is $Y_6Z_{15}O_{36}$ or $3(Y_2Z_5O_{12})$, Y representing the larger cations, mostly Fe'' with some Ce, U, etc. and Z the smaller cations, mostly Ti with some Fe''', V, Cr, etc. Davidites from 7 localities yield the same power diffraction pattern which can be fully indexed on this cell. Small amounts of contaminants, mostly rutile, can be identified in some reconstituted davidites. The reported morphology of davidite from Mozambique can be reconciled with the structure cell. Rough crystals of davidite from Billeroo, South Australia, also appear rhombohedral.--Auth.

3-4154. Molloy, Martin W., and Paul F. Kerr. DIFFRACTOMETER PATTERNS OF A.P.I. REFERENCE CLAY MINERALS: Am. Mineralogist, v. 46, no. 5/6, p. 583-605, 9 figs., 9 tables, May-June 1961, 19 refs.

The widely used studies published by the American Petroleum Institute on reference clay minerals are supplemented by revised X-ray diffraction information based on the original specimens. Chemically analyzed samples of kaolinite, dickite, halloysite, nontronite, montmorillonite, illite, attapulgite, and pyrophyllite are reexamined by recent X-ray diffractometer techniques. Spacing and intensity measurements and the corresponding diffractometer patterns are furnished for specimens oriented to enhance the basal reflections, subjected to glycolation and given 550°C. heat treatment. Constant instrument settings permit diffraction intensity comparison between different specimens, treatments, and species. The interpretation of the X-ray diffraction patterns in terms of the structural and thermal stability of the minerals is discussed.--Auth.

3-4155. Grigorev, D.P. RATE OF CRYSTALLIZATION OF MINERALS. Translated by Eugene A. Alexandrov: Internat. Geology Rev., v. 3, no. 8, p. 694-705, 10 figs., 3 tables, Aug. 1961, 31 refs.

Determination of the growth rate of crystals may be based on knowledge of the linear rate, the volume rate, and duration of crystallization. Direct measurements are possible where crystals are in process of growth as in the laboratory, saline waters, and at volcanic gaseous exhalations. Indirect but absolute measurements are possible by relating crystal zones with known occurrences in time; examples include calcite growth in belemnites, cave stalactites with smoke layers, and seasonally varied saline waters. Relative growth rates may be inferred from the nature of the intergrowth surface between different mineral crystals. Data are given on growth rates of gypsum, halite, calcite, fluorspar, quartz, hematite, pyrite, nepheline, bronzite, olivine, plagioclase, pyroxene, argentite, and corundum.--M. Russell.

3-4156. Stinson, Melvin C. THE MINERAL KINGDOM: California, Div. Mines, Mineral Inf. Service, v. 14, no. 8, p. 1-16, 6 illus., Aug. 1961, 2 refs.

A compilation of the mineral species listed in Dana's System of Mineralogy, v. 1 and 2. The silicates were classified according to H. Strunz's Mineralogische Tabellen as v. 3 of Dana has not yet been published. Mineral species found in California, species that were first discovered in California with the date of discovery, and minerals found only in California are indicated by symbols.--L.M. Dane.

3-4157. Frueh, Alfred J., Jr. THE USE OF ZONE THEORY IN PROBLEMS OF SULFIDE MINERALOGY, PART III; POLYMORPHISM OF Ag_2Te AND Ag_2S: Am. Mineralogist, v. 46, no. 5/6, p. 654-660, 4 figs., May-June 1961, 7 refs.

Three polymorphs of Ag_2Te exist between room temperature and the melting point. They are, in the order of increasing temperature: monoclinic, face-centered cubic, and body-centered cubic. The transformation temperature between the face-centered cubic and the body-centered cubic forms increases with a slight stoichiometric excess of Ag. The 3 polymorphs of Ag_2S are, in order of increasing temperature, monoclinic, body-centered cubic, and face-centered cubic. The transformation temperature between the body-centered cubic and the face-centered cubic forms decreases with a slight stoichiometric excess of Ag. An explanation, based on the relative shapes of the n (e) vs. E curves of the 2 cubic forms, is suggested to explain the increase of the stability range of the face-centered cubic structure with stoichiometric excess of Ag in both these compounds.--Auth.

3-4158. Piotrovsky, G.L. ON THE PROBLEM OF THE GENESIS OF CINNABAR AND METACINNABARITE. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 8, p. 652-657, table, Aug. 1961, 12 refs.

Experiments have been made on the synthesis of cinnabar and metacinnabarite in conditions close to those of hydrothermal processes of the formation of Hg deposits in nature. It may be concluded that during the formation processes of Hg the first to fall out is metacinnabarite. The fate of metacinnabarite depends on the medium that surrounds it. If hydrothermal waters carrying alkaline solutions Me_2HgS_2 will continue to effect the formed metacinnabarite the latter will gradually become a more stable red modification HgS, i.e., cinnabar. If the inflow of the mercury sulfide solutions stops or becomes so weak that under the counteraction of acid or even neutral vadose waters there will not be enough solvent in the form of ions S^{2-}, necessary for the changing of metacinnabarite into cinnabar, then the former will be preserved in the same state for a long time.--Auth. English summ.

3-4159. Erd, Richard C., and others. NOBLEITE, ANOTHER NEW HYDROUS CALCIUM BORATE FROM THE DEATH VALLEY REGION, CALIFORNIA: Am. Mineralogist, v. 46, no. 5/6, p. 560-571, 2 figs., 3 tables, May-June 1961, 15 refs.

Nobleite is a new hydrous calcium borate, $CaO \cdot 3B_2O_3 \cdot 4H_2O$, that has been found in the Furnace Creek borate deposits of the Death Valley region, California. Platy euhedral crystals of nobleite are produced by the weathering of colemanite and priceite veins in altered basaltic rocks of the Furnace Creek formation of late Tertiary age. The new mineral is associated with ulexite, gowerite, meyerhofferite, colemanite, several undescribed borates, ginorite, sassolite, a manganese oxide mineral, and gypsum.

Nobleite is biaxial (+), $\alpha = 1.500 \pm 0.003$, $\beta = 1.520 \pm 0.002$, $\gamma = 1.544 \pm 0.002$; 2V = 76° (calc); $r > v$ weak; $X \wedge \underline{a} = 29°$, Y = $\underline{b}$, $Z \wedge \underline{c} = -7°$. Hardness $\bar{3}$; measured specific gravity $2.09 \pm \bar{0}.01$.

Chemical analysis of the mineral gave: Li_2O 0.02, Na_2O 0.26, K_2O 0.06, CaO 16.96, SrO 0.11, Fe_2O_3 0.15, B_2O_3 60.80, H_2O 21.84; total 100.28%.

Nobleite is monoclinic; the space group is $P2_1/a$; $\underline{a} = 14.56 \pm 0.05$ Å, $\underline{b} = 8.01_6 \pm 0.02$ Å, $\underline{c} = 9.83_8 \pm 0.0\bar{2}$ Å, $\beta = 111° 45' \pm 10'$; $\underline{a}:\underline{b}:\underline{c} = 1.816:1:1.227$; cell volume 1066 $Å^3$; cell contents $\bar{4}[CaO \cdot 3B_2O_3 \cdot 4H_2O]$; calculated density 2.09_8.

The new mineral is named in honor of Dr. Levi F. Noble of the U. S. Geological Survey.--Auth.

3-4160. Strunz, H., THE CHALCOKYANITE SERIES: Am. Mineralogist, v. 46, no. 5/6, p. 758, 759, May-June 1961, 7 refs.

Some additional data on the chalcokyanite series are as follows:

Chalcokyanite	$CuSO_4$	Pmnb	Z = 4
		$a_o = 6.69$ Å, $b_o = 9.39$ Å, $c_o = 4.83$ Å	
		a:b:c = 0.797:1:0.576	
Zinkesite	$ZnSO_4$	Pmnb	Z = 4
		$a_o = 6.74$ Å, $b_o = 8.60$ Å, $c_o = 4.77$ Å	
		a:b:c = 0.784:1:0.555	
Synthetic	$CoSO_4$	Pmnb	Z = 4
		$a_o = 6.72$ Å, $b_o = 8.47$ Å, $c_o = 4.66$ Å	
		a:b:c = 0.793:1:0.550	

-- K. A. Riggs.

3-4161. Sclar, Charles B. DECOMPOSITION OF PYRITIZED CARBONACEOUS SHALE TO HALOTRICHITE AND MELANTERITE: Am. Mineralogist, v. 46, no. 5/6, p. 754-756, fig., May-June 1961, 5 refs.

The weathering product is a white effloresence. It formed on Au- and Ag-bearing pyritic Zn ore from the Dominican Republic. Halotrichite $[Fe^{+2}(Fe^{+3}, Al)_2(SO_4)_4 \cdot 22H_2O]$ is dominant, but melanterite $[FeSO_4 \cdot 7H_2O]$ also occurs with included shale and pyrite fragments. Halotrichite has a weak birefringence with $\gamma = 1.490 \pm 0.002$, $Z \wedge c = 38°$ The optic plane of melanterite is transverse to the elongation, and it has a small extinction angle (0°-12°). The other properties are: $\beta = 1.478 \pm 0.002$, 2V large (~75°).

Under a high relative humidity, pyrite decomposes, and acid sulfate solutions attack aluminous minerals. Evaporation results in crystallization of halotrichite and/or melanterite. --K. A. Riggs.

3-4162. Sidorenko, E. F. ON THE QUARTZ IN THE BROWN-COAL DEPOSITS OF DUBROVKA AND THE GLINSK-L'VOV REGION: Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 8, p. 658-663, 12 figs., Aug. 1961, 10 refs.

The question of new formations of quartz in petrified trees lying in lower Tortonian deposits is dealt with in the article. The mineral substance which replaced the wood is at the present moment all quartz. The microstructural analysis showed that the orientation of quartz was influenced by the walls of tracheids in regard to which the optical axes of quartz are embedded at an angle of 30°-32°, as well as across the cells of the tracheids.--Auth. English summ.

3-4163. Yang, Julie Chi-Sun. THE GROWTH OF SYNTHETIC CHRYSOTILE FIBER: Am. Mineralogist, v. 46, no. 5/6, p. 748-752, 3 figs., May-June 1961, 5 refs.

Synthetic chrysotile fibers were grown using magnesium oxide and silicic acid mixtures. The temperature range was 300-350° C. The pressure range was 1,230-1,800 p.s.i., and the time ranged from 5 to 10 days. The pH was controlled with sodium carbonate and the mineralizer was F^-.

Bundles of fibers of maximum length (50μ) can be grown in 6 hours, but better results are obtained with a longer reaction time. The chemical composition, crystal structure, and all of the other properties resemble those of natural chrysotile. Electron micrographs show that the individual fibers were more or less uniform in size.--K. A. Riggs.

3-4164. Kopp, Otto C., and others. THE HYDROTHERMAL CONVERSION OF MUSCOVITE TO KALSILITE AND AN IRON-RICH MICA: Am. Mineralogist, v. 46, no. 5/6, p. 719-727, 3 figs., 4 tables, May-June 1961, 7 refs.

Attempts to grow large single crystals of muscovite using muscovite cleavage plates as seeds and shredded muscovite as nutrient produced an Fe-rich mica and considerable quantities of the $KAlSiO_4$ polymorph called kalsilite. This result is of interest since kalsilite is not a common mineral in nature.

Optical data and X-ray measurements are presented for both the Fe-rich mica and the kalsilite.--Auth.

3-4165. Nosov, G.I., and F.E. Bogokina. GLAUCONITE FROM PALEOGENE DEPOSITS OF THE STALINGRAD VOLGA REGION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 60-66, 7 figs., 3 tables, pub. 1961, 11 refs.

The Paleogene of the Stalingrad Volga region is represented by marine, green-gray, terrigenous deposits, sand, friable sandstone, and siltstone, interbedded with silty claystone and clay. It is divided into 3 formations, reading upward: the Proleysk, Tsaritsin, and Buchak, and has a thickness of over 100 m.

A typical feature of Paleogene deposits is the abundance of glauconite. Sandy-silty facies consist of 10 to 70% glauconite. This study was done by various methods: microscopic, chemical, spectroscopic, thermal, X-ray, electronographic, and electron microscopic. Glauconite from all 3 formations is not substantially different, and therefore its description pertains to the entire Paleogene of the region.

Paleogene deposits of this region carry glauconite of 3 genetic varieties: round to granular, foliated, and pigmentary. The first is most common; the other 2 are fairly rare.

Round to granular glauconite usually occurs in beanlike to reniform grains peculiar to concretionary-gel formations. Grass-green, orientated aggregates of glauconite are fan-shaped, sheaflike and occasionally spiral, which is typical of the montmorillonite group minerals. The authigenic origin of round-grained glauconite in Paleogene deposits is beyond doubt.

Foliated glauconite occurs in typical elongated platy grains and accounts for about 10% of all glauconite in these rocks.

Residual greenish-brown, pleochroic segments of biotite-type micaceous minerals in some grains suggests the origin of foliated glauconite by metasomatic alteration of clastic micas during diagenesis.

Pigmentary glauconite has been determined visually only in silty argillaceous rocks. A microscopic study reveals the presence of this type in silty arenaceous rocks. It occurs in fine isometric grains, green, and slightly pleochroic. These scales fill up the interstices between clay minerals of the montmorillonite and hydromica type. The nature of its distribution, its secondary entry into the cracks, and its morphological features suggest a diagenetic origin.

The specific weight of Paleogene glauconite is 2.78 to 2.95, this high value being related to its high Fe content. The volume weight is 1.11 to 1.35 g./cm.^{3}, this low value being related to a high porosity, 54.2 to 62.4%.

According to the present concept, glauconite is a hydromica with Al replaced to a considerable extent by Fe and Mg. Paleogene glauconite is enriched in ferric Fe whose average content is about 20%. The average molecular ratio of oxides of Fe and Al is 1:2. The silicate modulus reaches 3.23 and confirms the hydromicaceous nature of glauconite. Paleogene glauconite is a hydrous alumoferrosilicate of K and Mg, with ferric Fe greater than ferrous.

Thermal curves for glauconite from each of the formations are nearly identical, approaching those obtained previously for Mesozoic glauconite. These thermal curves are similar to those for hydromicas.

X-ray analysis shows lines common to clay minerals, and an interplanar spacing typical of hydromicas; their diffraction pattern suggests that they belong to the dioctohedral ferruginous variety of hydromicas. Parameters of the elementary cell correspond to the single-layer hydromica structural type.

The electron-microscopic description of Paleogene glauconite shows that the morphology of glauconite particles is close to that of hydromicas with some specific features of its own.

Glauconite is fairly easily affected by chemical and physical weathering under hypergene conditions. Three stages of grain alteration are suggested in glauconite weathering.

Glauconite from Paleogene deposits of the Stalingrad Volga region in its main features, composition, and morphology is very similar to that from the Tertiary of the Russian platform and adjacent provinces. Mesozoic glauconite from the Moscow basin Upper Jurassic and Cretaceous sections resembles Paleogene glauconites. Such a similarity in composition and properties from several noncontemporaneous deposits suggests that its origin is related to a definite chemical environment in which marine and terrigenous glauconite formations are deposited.--J. W. Skehan.

3-4166. Segeler, Curt G. FIRST U.S. OCCURRENCE OF MANGANOAN CUMMINGTONITE, TIRODITE: Am. Mineralogist, v. 46, no. 5/6, p. 637-641, 3 figs., 2 tables, May-June 1961, 6 refs.

Tirodite, a Mn amphibole, was discovered in an Indian Mn deposit in 1938. It has now been found in the form of transparent pink crystals at Talcville, New York. The properties are compared with those of cummingtonite. Since the Talcville material is very low in Fe, the specific gravity and refractive indices are lower than those reported for the Indian material. $\underline{a} = 1.620$, $\beta = 1.630$ and $\gamma = 1.635$. New chemical analyses are given of the tirodite and 2 tremolites from Talcville.--Auth.

3-4167. Jaffe, Howard W., and others. MANGANOAN CUMMINGTONITE FROM NSUTA, GHANA: Am. Mineralogist, v. 46, no. 5/6, p. 642-653, 4 figs., 5 tables, May-June 1961, 16 refs.

Manganoan cummingtonite (Mg:Mn:Ca:Fe=60:35:3:2) from a manganese carbonate rock, Nsuta, Ghana, contains more Mn and less Fe than any cummingtonite previously described. The unit cell dimensions are: $\underline{a}_o = 9.531$ Å, $\underline{b}_o = 18.10$ Å, $\underline{c}_o = 5.326$ Å, $\beta = 102° 15'$. Crystals are pale greenish white, acicular-prismatic, nonpleochroic and colorless in transmitted light; $\alpha = 1.628$, $\beta = 1.642$, $\gamma = 1.650$, $2V = 74°$, biaxial negative, $Z \wedge \underline{c} = 22°$. G. = 3.12 (obs.), 3.19 (calc. from X-ray data), 3.12 (calc. from $(n-1)/d = K$). A revision in nomenclature of the series is suggested whereby cummingtonite, grunerite, and $Mn_7(Si_4O_{11})_{12}(OH)_2$ represent the Mg, Fe^{+2}, and Mn^{+2} end members of an essentially 3-component system.--Auth.

3-4168. Milton, Daniel J., and Jun Ito. GEDRITE FROM OXFORD COUNTY, MAINE: Am. Mineralogist, v. 46, no. 5/6, p. 734-740, 2 figs., 2 tables, May-June 1961, 9 refs.

Gedrite (Al anthophyllite) occurs in metamorphosed Ammonoosuc volcanics. The chemical composition gives the amphibole formula $AM_2M_5(Si,Al)_8O_{22}(OH)_2$. The amount of Al and Na is very high and the amount of K and Ca is very low. The sum of the cations, except for H, Si, and Al, is 7.20. The optical data,

chemical analysis, and X-ray powder data are included: $\alpha = 1.671$; $\beta = 1.681$; $\gamma = 1.690$; (-)2 V meas. ~75°; $a_o = 18.59$ Å; $b_o = 17.89$Å; $c_o = 5.30$ Å. The pycnometer density is 3.37. The density calculated from the chemical and X-ray data is 3.33.--K. A. Riggs.

3-4169. King, Elbert A., Jr. A FAYALITE-BEARING PEGMATITE, BURNET COUNTY, TEXAS: Am. Mineralogist, v. 46, no. 5/6, p. 747-748, May-June 1961, 2 refs.

The pegmatite strikes NW. through pink Precambrian granite composed of pink microcline, quartz, biotite, and hornblende. The pegmatite has an outer zone of perthitic pink microcline and an inner zone of smoky quartz. Fayalite is a very minor constituent, and biotite is the only other accessory. The fayalite occurs as anhedra and rough tabular crystals in the quartz core.

X-ray diffraction gives the following prominent peaks in decreasing order of intensity: 2.833, 2.502, 2.567, and 5.250Å. The optical data are: $\alpha = 1.819$, $\beta = 1.858$, $\gamma = 1.868$, Biaxial (-), r>v distinct, 2V = 53°.

The specific gravity is 4.22 ±0.02. The data indicate that the fayalite (Fe_2SiO_4) is not pure and contains other minor cations.--K. A. Riggs.

3-4170. Hurlbut, Cornelius S., Jr. TEPHROITE FROM FRANKLIN, NEW JERSEY: Am. Mineralogist, v. 46, no. 5/6, p. 549-559, 3 figs., 4 tables, May-June 1961, 15 refs.

A study of tephroite specimens from Franklin and Sterling Hill, New Jersey, showed in all of them the presence of thin sheets of willemite believed to be a product of exsolution. These sheets are oriented parallel to the {100} and {010} planes of tephroite with the a and c axes of tephroite and willemite parallel. It is believed that little Zn remains in the tephroite structure and that much of it reported in chemical analyses has been contributed by intergrown willemite. This conclusion is supported by experiments synthesizing tephroite. The indices of refraction and d spacing of {130} vary as would be expected with changes in amounts of MgO, FeO, and CaO.--Auth.

3-4171. Milton, Charles, and others. KIMZEYITE, A ZIRCONIUM GARNET FROM MAGNET COVE, ARKANSAS: Am. Mineralogist, v. 46, no. 5/6, p. 533-548, 3 figs., 3 tables, May-June 1961, 24 refs.

Kimzeyite, $Ca_3(Zr, Ti, Mg, Fe'', Nb)_2(Al, Fe''', Si)_3O_{12}$, is a new type of garnet occurring as dodecahedrons modified by trapezohedron at Magnet Cove, Arkansas, in a carbonatite with abundant apatite, monticellite, calcite, perovskite (dysanalyte), magnetite, and minor biotite, pyrite, and vesuvianite. It is dark brown, H about 7, isotropic, insoluble in acids, infusible before the blowpipe, D = 4.0, n = 1.94. The 3 strongest X-ray powder pattern lines with intensities as measured are 1.667 (10), 2.539 (9), 2.79 (8); the unit cell constant is 12.46 Å. Microchemical analysis gave CaO 29.8, ZrO_2 29.9, Ti_2O_3 5.0, MgO 0.5, FeO 0.8, Nb_2O_5 1.0, Al_2O_3 11.0, Fe_2O_3 13.4, SiO_2 9.6, sum 101.0 which computes to $Ca_{3.11}(Zr_{1.42}{}^{+4}Ti_{0.40}{}^{+3}Mg_{0.07}{}^{+2}Fe_{0.07}{}^{+2}Nb_{0.05}{}^{+5})(Al_{1.26}{}^{+3}Fe_{0.98}{}^{+3}Si_{0.94}{}^{+4})O_{12.00}$. Basically, this is $Ca_3Zr_2(Al_2Si)O_{12}$ with Ti replacing Zr and Fe replacing Al. Zr has been found in other garnets (schorlomite from Magnet Cove, melanite from Kaiserstuhl, Germany, and titanian andradite from Oka, Quebec) in quantity up to several percent, but in none of these is it a major constituent. Kimzeyite is named in honor of the Kimzey family, long known in connection with Magnet Cove mineralogy.--Auth.

3-4172. Konta, J., and L. Mráz. DILLNITE AND ITS RELATION TO ZUNYITE: Am. Mineralogist, v. 46, no. 5/6, p. 629-636, fig., 3 tables, May-June 1961, 23 refs.

New data on dillnite from Banská Belá, Czechoslovakia, are given. Dillnite is cubic, and occurs in minute tetrahedrons, with n = 1.563 and G = 2.87. The formula is $Al_{15}Si_6O_{25}(OH, F)_{18}Cl$. A new analysis has been made, with special attention to the determination of OH, F, and Cl.

Dillnite and zunyite form a series in which OH and F can substitute for each other within broad limits, but the content of Cl is nearly constant. Zunyite has a low F content and higher refractive index, and the name dillnite is used for material with high F content and lower index.--Auth.

3-4173. Kostov, Ivan. THE GENESIS OF KYANITE IN QUARTZ VEINS. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 8, p. 645-651, 6 figs., table, Aug. 1961, 15 refs.

The article deals with a new vein deposit of kyanite in Bulgaria and some considerations concerning the origin of kyanite veins in general. The kyanite is found in quartz veins within garnetiferous staurolite schists of probable Jurassic age. The kyanite crystals are up 10 cm. long along the c-axis and form parallel rodlike aggregates perpendicular to the selvages of the veins. The origin of the kyanite in the quartz veins is due to mobilization of Si and Al under the action of B and small quantities of alkalies, contained in pneumatolitic-hydrothermal or hydrothermal solutions. The temperature and the pressure are thought rather low but should be taken into consideration. It is suggested that the terms "stress" and "antistress minerals" be dropped and the terms "piezogene" and thermogene" be introduced, depending on whether pressure or temperature plays the prevalent role in the formation of the mineral.--Auth. English summ.

3-4174. Wilson, A., and J.K. Leary. THE OCCURRENCE OF CUSPIDINE IN PHOSPHORUS FURNACE SLAG: Am. Mineralogist, v. 46, no. 5/6, p. 759-761, fig., table, May-June 1961, 7 refs.

Small quantities of cuspidine ($3CaO \cdot CaF_2 \cdot 2SiO_2$) crystals were obtained from 3 types of crushed slags. The slags came from furnaces fed with phosphate rock containing F.

The single crystal X-ray data are as follows: $a_o = 7.57$ Å; $b_o = 10.57$ Å; $c_o = 10.93$ Å; $\beta = 69° 53'$; Z = 3.98; $\rho = 3.95$ g/cm.$^{-3}$

The optical data are as follows: $\alpha = 1.590$; $\beta = 1.593$; $\gamma = 1.602 \pm 0.002$; 2V = 58°; X∧a = 7°.

The optical axial plane is (010), the twinning plane is (001), and the poorly developed plane of cleavage is (110). The crystals are biaxial positive.--K. A. Riggs.

3-4175. Kittrick, J. A. THE DENSITY SEPARATION OF CLAY MINERALS IN THALLOUS FORMATE SOLUTIONS: Am. Mineralogist, v. 46, no. 5/6, p. 744-747, table, May-June 1961, 6 refs.

The density separation of clay minerals was the

only method of quantitative clay analysis which showed promise. Clay minerals acquire density variations in concentrated thallous formate solutions.

The apparent densities are obtained by adding 0.1 g. clay samples to 10 ml. of thallous formate solution of suitable density in 15 ml. vials. After 30 min. the suspension was centrifuged at 1,000 r.p.m. for 5 min. The mixtures were allowed to separate without stirring.

The easiest separation seemed to be that of kaolinite from montmorillonite. Kaolinite floated and montmorillonite sank over the whole specific gravity range tested. Illite and vermiculite sank in solutions of specific gravity of 3.00 and floated in those of 3.10. --K. A. Riggs.

3-4176. Gubelin, Edward J. EKANITE, ANOTHER NEW METAMICT GEM FROM CEYLON: Gems & Gemology, v. 10, no. 6, p. 163-179, 191, illus., map, 2 tables, Summer 1961, 13 refs.

Ekanite is a radioactive, metamict, gem material found in alluvial deposits at Ellawalla in the Ratnapura district. Physical constants include: color yellow-green, chatoyancy and asterism, specific gravity 3.280, refractive index 1.595 +.0002, and chemical formula $Ca_2Th\,[Si_4O_{10}]_2$. The results of heating experiments to determine the mineral's original structure are given. Radioactivity α-intensity, 20 disintegrations/sec. cm.^{2}; β-intensity, 90 disintegrations/sec. cm.^{2}; γ-intensity, 2,900 disintegrations/sec.g. Pb/U and Pb/Th ratios show age to be between 531 x 10^6 and 565 x 10^6 years.--M. Russell.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Areal and Regional Geology 3-3954; Geomorphology 3-3991; Mineralogy 3-4149, 3-4150.

3-4177. Sullivan, Walter. STUDIES SUPPORT LAVA-SEA THEORY: New York Times, v. 110, no. 37,857, p. 58, col. 4-6, illus., Sept. 17, 1961.

Seismic, petrologic, and other characteristics of Hawaiian volcanoes give support to a theory that a layer of relatively soft rock, about 60 mi. thick, lies within the mantle at a depth of 30-60 mi. It is postulated that this zone, first proposed by Beno Gutenberg from studies of seismic waves, is the source of most volcanic effusions. Lava of relatively low specific gravity upon melting is forced upward by the weight of the overlying more dense part of the mantle. The existence of such a layer helps to explain glacial rebound and continental drift.--M. Russell.

3-4178. Laganá, Tito. OBSERVACIONES SOBRE LA ACTIVIDAD DE LOS VOLCANES SANTIAGO (MASAYA) Y CERRO NEGRO (LEON) [Observations on the Activity of Santiago (Masaya) and Cerro Negro (Leon) Volcanoes]: Nicaragua, Servicio Geol. Nac., Bol. no. 4, p. 7-12, 4 illus., 1960; text in Spanish.

Santiago volcano has a double crater separated by a narrow wall which is gradually being destroyed. Gases have repeatedly issued from the Masaya (eastern) crater. For several years, these gases have damaged the local coffee plants. Since 1927, at least 2 intracrater land slides have apparently shut off the gas vent. This happened most recently on Oct. 13, 1960. When the vent was shut off before, gaseous activity resumed after a period of time. Cerro Negro volcano, on the other hand, has a recent history of repeated explosive eruptions, the latest having occurred on Sept. 28, 1960. The eruptions were accompanied by ash, lapilli, and volcanic bombs emitting from the crater. On Oct. 1, 1960, a lava flow issued from a fracture along the SE. side of the volcano, and flowed some 2 km. The front of the flow is about 300 m. wide. The flow rate averaged about 4 m. per hour.--A. A. Meyershoff.

3-4179. Minakami, Takeshi. STUDY OF ERUPTIONS AND EARTHQUAKES ORIGINATING FROM VOLCANOES (PART 1 OF 3). STATISTICAL RELATIONS BETWEEN ERUPTIONS AND EARTHQUAKES OF ASAMA VOLCANO. Translated by Kinkiti Musya: Internat. Geology Rev., v. 3, no. 8, p. 712-719, 7 figs., table, Aug. 1961, 21 refs.

Reports of volcanic eruptions and earthquakes originating from volcanoes indicate that seismic activity preceding the eruption is related not only to eruption magnitude and structure of the volcano, but also to viscosity of the lava at the time of eruption. This follows, since lava of higher viscosity meets greater resistance as it ascends from the magma chamber to the earth's surface and, consequently, greater stress will be produced within and beneath the volcano. The writer gives a condensed statistical breakdown of earthquakes and explosive eruptions of Asama volcano. The Asama earthquakes treated in the report are mainly those of rather low magnitude (T=1.0 sec., V=350) at the Asama Volcano Observatory, situated 4.2 km. E. of the center of the summit crater. This investigation showed that most of the explosive eruptions were preceded by an increase in micro-earthquakes. In addition, an experimental formula for predicting volcanic eruptions, based on the statistical relation between frequency of earthquakes originating from Asama and its explosive eruptions.--A. Eustus.

3-4180. Minikami, Takeshi, and others. STUDY OF ERUPTIONS AND EARTHQUAKES ORIGINATING FROM VOLCANOES (PART 2 OF 3). SOME CONTRIBUTIONS TO PREDICTION OF EXPLOSIVE ERUPTIONS OF VOLCANO ASAMA. Translated by Kinkiti Musya: Internat. Geology Rev., v. 3, no. 9, p. 803-813, 11 figs., table, Sept. 1961, 12 refs.

The authors describe the equipment and methods of seismometrical observations used at Asama over the past several years. Recently, a series of telerecording seismographs have been set at the summit crater, on the flank and at the foot of the volcano and wired to the Asama Volcano Observatory, where records are taken. The setting of the transducers is given and comparisons drawn with earthquake data of Sakura-Jima, 1956-1957. The authors conclude they are similar both in type of lava and position and nature of eruption. Eruptions occurring from 1954 to 1957 are correlated with statistical data, and 2 experimental formulas are evolved. The feasibility of volcanic-eruption forecasting is demonstrated by the first use of the formulas in forecasting - on the basis of Aug. 1958 increases in volcanic activity - the eruption of Oct. 3, 1958. About one month's warning was given to nearby residents and mountain climbers. The ensuing 3-month period of activity had its maximum in the Nov. 10 eruption, estimated at 10^{20} ergs kinetic energy. The authors believe

their formulas may be applied to other volcanoes whose ejecta is andesitic or dacitic lava.--A. Eustus.

3-4181. Wilshire, H.G. LAYERED DIATREMES NEAR SYDNEY, NEW SOUTH WALES: Jour. Geology, v. 69, no. 4, p. 473-484, 7 figs., 2 pls., July 1961, 24 refs.

Well-developed layering is expressed in size-sorting and orientation of elongate particles in 4 diatremes near Sydney [Australia]. The layering was produced by flow of a very viscous aggregate during emplacement of intrusive breccia rather than by air-sorting at an open vent which does not satisfactorily explain observed field relations. The size of particles in any particular layer depends on the distance between flow planes and only subordinately on relative velocities of flow in each layer. Some banded structures in nonbrecciated igneous intrusions are also briefly considered; the conclusion is that a similar process can cause mineralogical banding which may be further modified by dilatant effects.--Auth.

3-4182. McDougall, Ian. OPTICAL AND CHEMICAL STUDIES OF PYROXENES IN A DIFFERENTIATED TASMANIAN DOLERITE: Am. Mineralogist, v. 46, no. 5/6, p. 661-687, 10 figs., 3 tables, May-June 1961, 23 refs.

At Red Hill in southern Tasmania a large near vertical dikelike intrusion of tholeiitic dolerite, 1 mi. in width and about 5 mi. in length crops out. In this body marked differentiation has given rise to a series of rocks varying continuously from undifferentiated dolerite to granophyre; the latter occurring in the highest parts of the intrusion. Five pyroxenes, separated from rocks representative of the differentiation series, have been chemically analyzed and the optical properties determined. These pyroxenes are a coexisting pigeonite and augite, 2 ferroaugites, and a ferrohedenbergite. To outline the complete fractionation series a number of other pyroxenes have been determined optically. Orthopyroxene occurs as a primary phase in a zone approximately 50 ft. wide in dolerites adjacent to, and including, the chilled contacts of the intrusion, but elsewhere pigeonite is the only Ca-poor pyroxene present. Pigeonite also has crystallized in the dolerites adjacent to the contacts, where it has, in some cases, partially inverted to orthopyroxene. A member of the augite series crystallizes in cotectic equilibrium with the pigeonite and during fractionation both pyroxenes become progressively enriched in Fe, primarily at the expense of Mg. At the limit of the 2-pyroxene field pigeonite ceases to form but the Ca-rich pyroxene continues to crystallize, steadily increasing in Fe content with fractionation, ultimately to attain the composition of ferrohedenbergite in the more acid granophyres. The trend of crystallization with fractionation closely parallels that from the Skaergaard intrusion. Exsolution phenomena occur in both series of pyroxenes throughout much of the sequence, but are virtually absent in the ferrohedenbergite, probably owing to the relatively low temperature of crystallization.--Auth.

3-4183. Stone, M., and W.G.C. Austin. THE METASOMATIC ORIGIN OF THE POTASH FELDSPAR MEGACRYSTS IN THE GRANITES OF SOUTHWEST ENGLAND: Jour. Geology, v. 69, no. 4, p. 464-472, 3 figs., pl., July 1961, 17 refs.

Evidence is presented to show that the big potash feldspars in the aplite-pegmatite complex at Tremearne and in the Carnmenellis granite in western Cornwall have grown in solid or nearly solid rock. It is considered that the rocks present before metasomatism were aplitic and that these rocks have been permeated by a fluid phase containing K; there is evidence that this dispersed phase caused the metasomatism and recrystallization of the aplitic rocks to produce porphyritic granite and pegmatite. These conclusions can be extended to other granitic rocks of SW. England.--Auth.

3-4184. Eremeev, V.P. POTASSIUM METASOMATISM IN GRANITES OF SOUTHEASTERN TUVA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 86-91, 4 figs., 2 tables, pub. 1961, 6 refs.

The southeastern part of Tuva, made up chiefly of Proterozoic gneiss and marbles, is cut in a number of places by intrusions of various composition and age including Precambrian biotite granites, Lower Cambrian ultrabasic rocks, and the "Tannuol" Salair complex, and by minor hybrid granite and pegmatite intrusions.

Red granites are distinctive among the "Tannuol" granitoids and especially in southeastern Tuva where they occur usually alongside deep-seated faults. The red granites of different intrusions are externally similar, but under the microscope they show marked differences.

A petrographic study of the southeastern Tuva granites indicates that post-Cambrian, pre-Devonian plagioclase granites were intruded and consolidated. Subsequently they were acted upon by alkaline solutions associated with the intrusions themselves. As a result the intrusions were autometasomatically altered, which led to the replacement of plagioclase by latticed microcline. The replacement process was most complete in the central part of the intrusion and less so toward the periphery.--J. W. Skehan.

3-4185. Sobolev, N.D. NEYVITE - A NEW VEIN ROCK: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 99-104, 2 figs., 2 tables, pub. 1961, 7 refs.

Ultrabasic rocks of the Urals belong to a single extrusive complex, rich in various ultrabasic to acid vein rocks. The Uralian ultrabasics form 3 belts: the western, central, and eastern. In the central belt, the largest massif trending meridionally is made up of peridotite and serpentine and is cut by numerous veins designated as microdiorite and diorite-porphyrite. Students of the western and eastern zones believe these veins are comagnetic with the ultrabasic intrusion and belong to a vein series from dunite to albitite, plagioaplite, and aplite.

Detailed petrographic and chemical studies of these veins has shown 2 phases of intrusion. A post-magmatic origin of the veins is precluded, and an igneous origin of these rocks is considered certain. The regularity in the formation of such veins, their massive aspect, and a definitely magmatic origin, make it expedient to designate these rocks as a new group named neyvite (after the Neyva river). Albitite is regarded as an ultimate residue of differentiation and crystallization of a gabbro magma, with its desilication in a reaction with the enclosing rocks. Albitite is related to hornblendite by way of neyvite. The differentiation of this new rock, neyvite, is justified petrographically by comparison with the nepheline-pyroxene rocks of the series pyroxene-

jakupirangite-melteigite-iolite-urtite, differing in their quantitative ratios of pyroxene and nepheline. In our example the differentiation is as follows: hornblendite, with up to 20% albite; neyvite, with 20 to 80%; and albitite, with 80 to 100% albite.--J. W. Skehan.

3-4186. Tomkeieff, S.I. ALKALIC ULTRABASIC ROCK AND CARBONATITES IN THE U.S.S.R.: Internat. Geology Rev., v. 3, no. 9, p. 739-758, 5 figs., 2 tables, Sept. 1961, 95 refs.

This article gives a brief review of recent Soviet publications on the subject of alkalic ultrabasic rocks associated with carbonatites in the Kola peninsula and Siberia. These rocks are found mainly as complexes infilling diatremes or cycloliths and, as a rule, consist of 1, 2, or more rock series, of which the principal are the following: 1) normal calc-alkali or alkali series ranging from ultrabasic to intermediate, 2) per-alkalic jacupirangite-urtite series, 3) nepheline syenites and fenites, and 4) carbonatites.

Taking into consideration this Soviet work and using the Kola peninsula and Siberian material it seems possible to produce a genetic scheme embracing all 4 series, if it is accepted that, in addition to the crystallization-differentiation, there is a diffusion-differentiation conditioned by an upward thermodiffusion of alkalies and volatiles, and among these, more particularly, carbon dioxide and water. Such a diffusion-differentiation would promote the formation of the per-alkalic magma from the normal alkalic magma. The newly formed jacupirangite-urtite magma, being highly chemically active, would give rise to 2 parallel processes, nephelinitization and carbonatization. These 2 processes would be conditioned by an exchange reaction between the alkali carbonates present in the fluidal fraction of the magma and the calcium and magnesium silicates present either as minerals or molecules in the magma. Such a reaction can be visualized as:

$$\underset{\text{anorthite}}{CaAl_2Si_2O_8} + Na_2CO_3 \rightleftarrows \underset{\text{nepheline}}{2NaAlSiO_4} + \underset{\text{calcite}}{CaCO_3}$$

The production of a nepheline molecule would lead to an intensive alkali auto- and hetero-metasomatism, transforming the granitic country rock first to fenite and this to a mobilized fenite and eventually to nepheline syenite. At the same time the production of calcium, magnesium, and iron carbonates would lead to an equally intensive carbonate auto- and hetero-metasomatism. The remaining solution would give rise to nephelinoliths and carbonatites. Postulating alkali carbonates as the transported material during the diffusion-differentiation, one must abandon the idea of an existing "carbonatite magma" in favor of "magmatic carbonates" forming through an exchange reaction during the hydrothermal stages of the magmatic consolidation.--Auth.

3-4187. Godlevsky, M.N., and A.D. Bataliev. MAFIC MINERALS IN THE DIFFERENTIAL TRAP-ROCK INTRUSIVES OF THE NORIL'SK REGION. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 9, p. 784-802, 16 figs., 12 tables, Sept. 1961, 21 refs.

This paper gives a description of crystal optics of olivines, clinopyroxenes, and orthopyroxenes from differentiated trap intrusions of the Norilsk region. The Fe-content of these minerals increases during differentiation from the picrite horizon up to the uppermost differentiation products. In the contaminated lower layer the Fe-content increases likewise. At the initial stages of crystallization of every rock the formation of pyroxenes high and low in Ca occurs simultaneously, but in the final stage only pyroxenes low in Ca remain stable, indicating an exhaustion of Ca in the melt.--Auth. English summ.

3-4188. Pavlova, T.G. THE KARSAKPAY ALKALINE AND NEPHELINE SYENITE MASSIF AND ITS STRUCTURAL POSITION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 67-78, 7 figs., 2 tables, pub. 1961, 8 refs.

The Karsakpay massif of alkaline and nepheline syenites is in the western part of central Kazakhstan. It is of interest as a definite genetic type of alkaline rocks related to a granitoid magma. This massif lies in the axial part of the Precambrian Maytyubin anticlinorium, is oval, somewhat elongated NNW., and has an area of 7 to 8 km^2.

Metasomatic phenomena have affected rocks of the massif to such an extent that the composition of the original rock can only be surmised. Field relations, petrographic studies, and chemical analyses suggest a contamination of the magma during the formation of the syenite massif. In addition to widespread metasomatic development of albite, there is evidence of metasomatic formation of nepheline.

The enclosing gneissoid granites are assigned to Precambrian; the intrusion of the syenite is considered to be related to intensive Variscan folding; and the gabbro-amphibolites are considered as basic intrusions of Caledonian age.--J. W. Skehan.

3-4189. Ayanov, V.M. MINOR INTRUSIONS IN DZHUGA MOUNTAIN AND IN THE BASIN OF KISHA AND BEZYMYANNAYA RIVERS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 79-85, 4 figs., 3 tables, pub. 1961, 8 refs.

Two intrusive complexes are present in this part of the northwestern Caucasus' intermediate zone. The Chelepsy granitoid intrusions are pre-middle Carboniferous. These granitic rocks enclose rocks of a younger intrusive complex, described as minor intrusions and developed chiefly in Dzhuga mountain. These include diorite, granodiorite, quartz diorite, leucocratic granite, and granitic aplite. The formation of minor intrusions, including their hydrothermal derivatives, was completed prior to the second half of the Early Permian. Hydrothermal veins contain barite, quartz, and calcite as principal minerals, and galena and chalcopyrite as accessories.

Petrographic and spectrographic studies indicate that the minor intrusions, especially in their acid phase, are "contaminated" by Cu (to a slight extent), Pb (more), and Ba (much), in amounts exceeding those for an ore-free mineralization. This suggests a potential ore content in this intrusion. Developed during the hydrothermal stage of the intrusion was a paragenesis of galena, chalcopyrite, and barite, corresponding to that of Pb, Cu, and Ba, dispersed in the igneous formations.--J. W. Skehan.

3-4190. Berge, Charles W. HEAVY MINERALS STUDY OF THE INTRUSIVE BODIES OF THE CENTRAL WASATCH RANGE, UTAH: Brigham Young Univ., Dept. Geology, Brigham Young Univ. Research Studies, Geology Ser., v. 7, no. 6, 31 p., 7 figs., geol. map (in pocket), 4 pls., 1960, 41 refs.

The Little Cottonwood, Alta, Clayton Peak, and Park City stocks occur generally in a line from W.

to E. within the N.-trending central Wasatch Range at its intersection with the E.-W. structures of the Uinta uplift, and represent the only large intrusions in either range. A heavy mineral petrographic study of these 4 stocks showed these intrusions to become progressively more acidic to the W.; a statistical comparison, using Pearson's Product-Moment Correlation Coefficient and Contingency Coefficient, confirmed the presence of greater quantities of early-forming minerals in the eastern intrusions. The Park City stock (quartz diorite porphyry), easternmost of the 4 stocks, and the Little Cottonwood stock (adamellite) on the W. show the greatest contrast in general mineral content and rock texture and in the amount and type of heavy constituents. The Clayton Peak and Alta stocks (granodiorites) appear intermediate in essentially all respects. From W. to E., the stocks become more basic, showing less quartz, K feldspar, biotite and sphene, and more plagioclase (more calcic to the E.), hornblende, pyroxene, opaques, and zircon. The stocks become smaller, more highly altered (hydrothermal), and have solidified at shallower depths.--Auth.

3-4191. Johnson, M.R.W. POLYMETAMORPHISM IN MOVEMENT ZONES IN THE CALEDONIAN THRUST BELT OF NORTHWEST SCOTLAND: Jour. Geology, v. 69, no. 4, p. 417-432, 6 figs., 2 pls., table, July 1961, 19 refs.

Microscopic examination of the textures and mineral orientations in the rocks within the Moine thrust belt is used in conjunction with the field evidence, which indicates several movement episodes of differing intensity and character, to elucidate the changing physical conditions in the NW. thrust front of the Caledonides. Many of the mylonites were formed in an early phase of the orogeny, in narrow (primary) "movement zones" in which the movements are concentrated. During a later phase, recrystallization and new mineral growth, under green schist or epidote-amphibolite facies conditions, occurred in the movement zones and outside them in places where secondary movement zones developed. Later phases show rather brittle, localized deformations, often following the earlier movement zones.

Comparison is made of the movement zones and shear belts of the thrust belt with those found in other orogenic belts; and also with those found in nearby parts of the Caledonian belt. It is suggested that the primary movement zones are formed by sliding and reactivation of the basement early in the Caledonian orogeny.--Auth.

10. SEDIMENTARY PETROLOGY

See also: Geomorphology 3-3970; Stratigraphy 3-4032; Geohydrology 3-4216; Fuels 3-4268; Engineering Geology 3-4281.

3-4192. Buffington, Edwin C. EXPERIMENTAL TURBIDITY CURRENTS ON THE SEA FLOOR: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 8, p. 1392-1400, 3 figs., Aug. 1961, 22 refs.

Marine turbidity currents provide an explanation, frequently the best or only explanation, for a wide variety of phenomena. The circumstantial evidence for their efficacy is very convincing, but there is scant empirical evidence bearing on their mode of origin and none on the presence of high-density, high-velocity currents in the ocean.

Experiments intended to simulate the conditions of nature have been conducted on the sea floor off San Diego, California, in an attempt to produce high-density currents. The experiments were conducted by sliding a mass of pre-mixed sediment from an elevated, tilted container 40 ft. below sea-level on a naturally sloping sea floor and observing the resulting flow directly by utilizing SCUBA.

The initiation of a flow appears sensitive to the proportions of the sediment grain sizes and therefore cohesiveness of the sediment mass, the method of mixing, and total volume. Initiation on an open slope appears much less likely than on the walls of a confined feature such as a gully or canyon. Natural analogies do not tend to support the existence of high-density high-velocity, marine turbidity currents.--Auth.

3-4193. Hubbell, David W. PROGRESS REPORT NUMBER 2. INVESTIGATIONS OF SOME SEDIMENTATION CHARACTERISTICS OF SAND-BED STREAMS: U.S. Geol. Survey, Repts., Open-File Ser., 78 p. 15 figs., 8 tables, 1960, 7 refs.

Hydraulic and sediment characteristics at 6 river sections upstream and downstream from the confluence of the Middle Loup and Dismal rivers were measured and studied to determine some of the interrelationships between variables and the differences that exist between common variables when 2 flows unite. The 2 streams, which flow through the Sandhills region of Nebraska, have about the same water discharge, sediment concentration, and particle-size distribution of suspended sediment and bed material. Sediment discharges and flow resistances varied widely, although water discharges remained almost constant. The factor affecting the variations was water temperature, which ranged from 32° to 80°F. The bed form, which also varied with the water temperature, seemed to have a dominating influence on the sediment discharge, flow resistance, and possibly the vertical distribution of velocity and suspended sediment. Multiple regression with parameters derived from dimensional analysis yielded an expression for predicting the flow resistance and the widths and depths of individual channel sections. Contrary to those near many other confluences, slopes were steeper and channels were wider downstream from the junction of the 2 rivers than they were upstream. --Auth.

3-4194. Straaten, L.M.J.U. van. SEDIMENTATION IN TIDAL FLAT BASINS: Alberta Soc. Petroleum Geologists, Jour., v. 9, no. 7, p. 203-226, 5 figs., July 1961, 239 refs.

A brief summary of the main sedimentological properties of recent Dutch tidal flat formations, both in the estuarine river mouths in the SW. of the Netherlands, and on the landward side of the barrier islands in the N. Except for the areal distribution of the various features, little difference exists between these 2 regions. Much the same picture is shown by other recent tidal flat formations in Western Europe.

It is not unlikely, however, that in more distant parts of the world, e.g. in the tropics or along desert coasts, they have some essentially different properties. At present, very little is known about the sedimentology of these other areas. This may make it difficult to decide, when dealing with fossil sediments,

whether they were formed in tidal flat environments, or under other littoral or shallow marine conditions. A main criterion is, probably, the presence of tidal channel deposits.

As yet, not many convincing examples have been given in the literature of such tidal flat formations. One of the causes may be that these sediments have a great chance to be eroded shortly after deposition, either by wave action (during a transgression of the sea), or by subaerial erosion (during a regression). Moreover, it may be expected that, where they are preserved at all, each individual formation rarely exceeds a few dozens of meters in thickness.--Auth.

3-4195. Donaldson, Alan C. INTERPRETATION OF DEPOSITIONAL ENVIRONMENTS OF LOWER ORDOVICIAN CARBONATES IN CENTRAL APPALACHINS [sic]: West Virginia Acad. Sci., v. 31/32, p. 153-161, 3 figs., 1959-1960, 34 refs.

The environment of deposition of carbonate rocks can be inferred from various distinguishable textures and structures. The Lower Ordovician Stonehenge limestone, near Axemann, Pennsylvania, consists of calcirudite, calacarenite, calcilutite, algal limestone, and finely crystalline dolomite, interpreted to have been deposited in marine cycles ranging from nonrestricted normal saline conditions with strong bottom-current circulation to restricted penesaline conditions with weak bottom-current circulation. Analogies are drawn with the Grand Bank of the Bahamas.--M. Russell.

3-4196. Lerbekmo, John F. POROSITY REDUCTION IN CRETACEOUS SANDSTONES OF ALBERTA: Alberta Soc. Petroleum Geologists, Jour., v. 9, no. 6, p. 192-199, 8 figs., June 1961, 2 refs.

Low porosity in Cretaceous sandstones in Alberta is often the result of post-depositional changes. Misinterpretation of a secondary texture as primary will probably lead to erroneous evaluation of a sandstone as a potential reservoir.

Silica cementation takes place as overgrowths on detrital quartz grains. Incomplete cementation produces easily recognized crystal faces and some remaining porosity, whereas cementation removes all effective porosity and leaves contacts sometimes mistaken for those caused by pressure solution.

Carbonate cementation often follows partial silica cementation. It tends to be local or patchy, and reduction of porosity to less than 5% may still leave the sandstone relatively friable.

Secondary clay cement may be difficult to distinguish from detrital clay, though the former is more even in texture, composition, and color than the latter. Authigenic clay is common in the lower Mannville and basal Belly River where it may effectively fill all initial pore space.

Porosity loss by pressure solution and compaction is general in chert-rich sandstones after burial of a few thousand feet. However, lack of silica cementation in such sandstones makes them better potential reservoirs at shallow depths than quartz sandstones. --Auth.

3-4197. Potter, Paul Edwin, and Wayne A. Pryor. DISPERSAL CENTERS OF PALEOZOIC AND LATER CLASTICS OF THE UPPER MISSISSIPPI VALLEY AND ADJACENT AREAS: Geol. Soc. America, Bull., v. 72, no. 8, p. 1195-1249, 17 figs., 2 pls., 8 tables, Aug. 1961, 140 refs.

Three major dispersal centers of the Paleozoic, Cretaceous, and Tertiary clastics of the upper Mississippi Valley and adjacent areas were located through integrated study of petrography, directional structures, facies maps, and regional stratigraphic relations.

In pre-Mississippian time, nearly all the clastics originally were derived from the Precambrian rocks centered around the Lake Superior region of the Canadian Shield. Relatively modest streams supplied sands and muds, and recycling on a stable craton produced mature and supermature sandstones.

The second and third major dispersal centers resulted from Appalachian orogenic activity. Although some contributions from the Lake Superior region and Canadian Shield continued, the tectonic borderlands of the northern Appalachian mountains were the chief dispersal center of Mississippian and Pennsylvanian clastics. In post-Pennsylvanian time, this center shifted to the E. of the southern Appalachian mountains. The post-Devonian clastic sediments were transported to the shallow marine shelves, coastal plains, and small deltas of the craton by a series of large, recurring drainage systems.

Despite major shifts in dispersal centers, the slope of the craton in the upper Mississippi Valley and adjacent areas has persisted to the S. and SW. throughout Paleozoic, Mesozoic, and Tertiary time.

Inherent in the foregoing regional results are some problems of general interest. These include sedimentary differentiation, intrastratal solution, and the relationships between paleoslope, regional unconformities, and cross-bedding directions.--Auth.

3-4198. Schwarzacher, Walter, and Kenneth L. Hunkins. DREDGED GRAVELS FROM THE CENTRAL ARCTIC OCEAN (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 1, p. 666-677, 5 figs., 4 tables, Toronto, University of Toronto Press, 1961) 20 refs.

A series of 9 bottom trawls was made in the Arctic Ocean from drifting station Alpha. The trawls were taken in the area between 84° and 85°N. and between 138° and 152°W. All trawls produced high percentages of gravel. Macroscopic and microscopic analyses showed these gravels to be predominately sedimentary rocks. Few igneous or metamorphic specimens were found. One fossiliferous sandstone specimen is Permo-Carboniferous in age. Bottom cores contained similar pebbles at depths in the sediment of up to 115 cm. below the sea floor. Studies of the striation, roundness, and shape of the pebbles reveal them to be typical glacial material which has undergone little or no water transport.

It is concluded that these gravels have been rafted by ice from a shore containing active glaciers. Consideration of Arctic Ocean circulation, Pleistocene glaciation, and lithology make it probable that the source area was Axel Heiberg Island, Ellesmere Island, or the northern coast of Greenland.--Auth.

See also: Sedimentary Petrology 3-4193.

3-4199. Nelson, R. William. IN-PLACE MEASUREMENT OF PERMEABILITY IN HETEROGENEOUS MEDIA. 2. EXPERIMENTAL AND COMPUTATIONAL CONSIDERATIONS: Jour. Geophys. Research, v. 66, no. 8, p. 2469-2478, 4 figs., Aug. 1961, 17 refs.

The computational problem pointed out in pt. 1 [GeoScience Abstracts 2-2664] of this sequence of papers is evaluated in some detail. The problem arises from the need for compromise between the accuracy of calculated permeability and the ease of performing the calculation. Finite difference methods were expected to provide such a compromise. However, imprecision in numerical differentiation prevented use of the difference method. A study of the accuracy required for measuring permeability indicates that 7.5 times as much variation is allowable in the permeability as in the potential pattern. Since potential patterns are the tools needed to treat practical problems, errors in permeability measurements as great as 37 to 75% may be tolerated and still provide answers within the common engineering accuracy range of 5 to 10%. Linear flow approximations are found to give rather reliable permeability results for lateral flow systems. The geometrical shape of net elements in a properly constructed flow net for heterogeneous soils is utilized in the method. An expression for the approximation error is presented for application to any problem being analyzed.--Auth.

3-4200. Bear, Jacob. SOME EXPERIMENTS IN DISPERSION: Jour. Geophys. Research, v. 66, no. 8, p. 2455-2467, 13 figs., 2 tables, Aug. 1961, 6 refs.

The aim of the experiments was to study the tracer distribution caused by dispersion in 1- and 2-dimensional fields of flow and to compare the experimental results with the theoretical formulas developed previously by the author. Two models were employed: a 1-dimensional sand column and a 2-dimensional Christiansen filter. It has been experimentally verified that the growth of the transition zone which develops when an initially abrupt interface is displaced from its original position depends upon the path of the mean point and is independent of the flow velocity. The variance which was used to define the tracer concentration distribution was shown to be directly proportional to the total distance traveled by the mean point of the distribution. The constant of dispersion of the porous medium was determined experimentally. The effect of the lateral constant of dispersion for cases where the interface makes an angle with the direction of the uniform flow was demonstrated. Experimental results agree with theory.--Auth.

3-4201. Colby, Bruce Ronald. EFFECT OF DEPTH OF FLOW ON DISCHARGE OF BED MATERIAL: U.S. Geol. Survey, Water-Supply Paper 1498-D, 12 p., 4 figs., 1961, 7 refs.

Computations with the Einstein procedure and an empirical analysis of data from flumes and natural streams agree qualitatively in showing a complex effect of depth of flow on the relationship of discharge of bed material to mean velocity. The effect of increasing the depth is in the opposite direction at low mean velocities from what it is at high mean velocities and is almost negligible at some intermediate velocities. Depth of flow has an equally complex and varied effect on the relationship between discharge of bed material and stream power and has, except at low shears, a large but simpler effect on the discharge of bed material as related to shear velocity with respect to the sediment particles.--Auth.

3-4202. Reed, J. E., and M. S. Bedinger. PROJECTING THE EFFECT OF CHANGED STREAM STAGES ON THE WATER TABLE: Jour. Geophys. Research, v. 66, no. 8, p. 2423-2427, 7 figs., Aug. 1961, 3 refs.

The position and shape of the water table under certain conditions may be considered to be the sum of 2 components of head, namely, the boundary component and the accretion component. In an aquifer of given hydraulic characteristics, the boundary component of head is determined by the stream stage and areal shape of the aquifer; the accretion component of head is determined by vertical gain or loss of water to the aquifer and by the areal shape of the aquifer. The boundary component may be obtained by electric-analog methods. By subtracting the boundary component from the observed position of the water table, the accretion component can be obtained. A change in river stage imposes a new boundary component on the system. The effect of changed stream stages on the water table may be obtained by adding the accretion component to a new boundary component caused by changed stream stages.--Auth.

3-4203. Ramsahoye, L. E., and Solomon M. Lang. A SIMPLE METHOD FOR DETERMINING SPECIFIC YIELD FROM PUMPING TESTS: U.S. Geol. Survey, Water-Supply Paper 1536-C, p. 41-46, fig., 1961, 2 refs.

A simpler solution which greatly reduces the time necessary to compute the specific yield by the pumping-test method of Remson and Lang is presented. The method consists of computing the volumes of dewatered material in the cone of depression and comparing it with the total volume of discharged water. The original method entails the use of a slowly converging series to compute the volume of dewatered material. The solution given herein is derived directly from Darcy's law.--Auth.

3-4204. Remson, Irwin, and others. WATER LEVELS NEAR A WELL DISCHARGING FROM AN UNCONFINED AQUIFER: U.S. Geol. Survey, Water-Supply Paper 1536-B, p. 27-39, 2 figs., 2 tables, 1961, 9 refs.

The differential equation describing unsteady radial flow to a well in an unconfined aquifer has no simple solution in terms of elementary functions because the transmissibility decreases as the aquifer is dewatered. A numerical solution and type curves are presented showing the head of water in a homogeneous aquifer as a function of radial distance from the well and time elapsed after the water level in the well is lowered to and maintained at a given level. This solution is similar to one presented by J. R. Philip in 1955 for linear diffusion in a flow system in which diffusivity is concentration dependent.--Auth.

3-4205. Austin, Charles R. EARTHQUAKE FLUCTUATIONS IN WELLS IN NEW JERSEY: New Jersey, Dept. Conserv. & Econ. Devel., Div. Water Policy & Supply, Water Resources Circ. 5, 13 p., 5 figs., table, 1960, 7 refs.

It is now known that the shock wave resulting from

an earthquake, in being transmitted through the earth may disarrange, either temporarily or permanently, the structure of a water-bearing formation and cause fluctuations of water levels. This idea has been confirmed by correlating the time of occurrence of many of these fluctuations with the recorded time of an earthquake. Since 1950, about 200 sudden fluctuations of water levels [from a trace to 2.66 ft.] in 38 wells in New Jersey definitely have been correlated with earthquakes. Thus, the maintenance of water-stage recorders on wells, in the course of ground-water investigations, has provided a new means of studying earthquakes and many observation wells are, in effect, crude seismographic stations.

A careful study of the recorder charts indicates that there has been no permanent effect on the water levels in any well in New Jersey. This suggests that there also has been no permanent effect on the water-bearing formations.

A map shows the location of all wells whose hydrographs have shown the results of earthquake shocks since 1950. Table 1 shows the name of each well and its geographic location, the number of times fluctuations have been observed, the depth of the well, and the character and name of the water-bearing formation. These wells range in depth from 8 to 843 ft. Most of the wells described in this report are in sands and gravels of the several Coastal Plain formations, 8 are in the reddish sandstones of the so-called Triassic belt of rocks, 4 are in sand and gravel laid down during the ice age, and one is in ancient crystalline rock called the Wissahickon formation.--From p. 2.

3-4206. Kohout, F.A. FLUCTUATIONS OF GROUND-WATER LEVELS CAUSED BY DISPERSION OF SALTS: Jour. Geophys. Research, v. 66, no. 8, p. 2429-2434, 6 figs., Aug. 1961, ref.

Certain wells tapping the zone of diffusion between fresh and salt water in the Miami, Florida, area showed anomalous residual water-level drawdowns after being pumped. Graphs comparing fluctuations of water levels and chloride contents show that the anomalies are caused by dispersion-motivated changes in the density of the water in the casing. Dispersion produces fluctuations of water level under natural conditions as well as after pumping. In an area where true fluctuation of the water table due to normal recharge and discharge amounted to about 3 ft., dispersion produced an observed water-level fluctuation of 0.7 ft. The fluctuations occur so subtly that erroneous conclusions concerning changes in ground-water storage are possible unless interpreted carefully.--Auth.

3-4207. Hall, E. GROUND-WATER RESOURCES OF WEYBURN MAP-AREA, SASKATCHEWAN: Canada, Geol. Survey, Water Supply Paper 329, 7p., map (in pocket), scale 1:253, 496, 1960.

Area of about 12,000 sq. mi. directly S.E. of Regina. Pleistocene unconsolidated deposits are composed mainly of till, outwash deposits, glacial-lake deposits, and alluvium. Bedrock is divided into the Riding Mountain formation, consisting of gray to greenish-gray shale, in part siliceous; Eastend formation, consisting principally of fine-grained sand and silts, with some shale and thin seams of lignite; Ravenscrag formation, consisting of sand, silt, shale, clay, and lignite of a thickness great enough for commercial use.

Randomly scattered through the till are pockets of silt and sand that form aquifers supplying water to most wells in the moraine. The outwash composed of sand and gravel furnishes the most easily developed and dependable water supplies within the map-area. Poor wells are dug in the lake sediments or alluvium. Among bedrock formations, only the Ravenscrag has producing wells. Seams of sand and lignite in the Ravenscrag formation are large lens-like deposits, which are good aquifers containing a soft water with a sodium carbonate concentration. --M. Stewart.

3-4208. U.S. Congress, Senate, Select Committee on National Water Resources. WATER RESOURCES ACTIVITIES IN THE UNITED STATES. WATER RESOURCES OF ALASKA: U.S. 86th Congress, 2d sess., 1960, Committee Print no. 19, 21 p., 2 figs., tables, Washington, D.C., U.S. Govt. Print. Off., 1960.

The report points out that the 4 major problems which will hinder development of good water supplies in Alaska relate to freezing conditions and the presence of permafrost N. of the Alaska Range; quality of water as related to the presence of Fe and glacial flour; the presence of impervious consolidated rocks limiting the availability of ground water; and difficulties of waste disposal during winter months. Irrigation in Alaska is still in its infancy, but the report suggests that eventually some 50,000 acres may be irrigated. Water power potential is enormous and constitutes one of the valuable resources of the state. It is estimated that the prime power potential at 168 sites is somewhat over 13 million kilowatts. This is a very large percentage of the total hydroelectric power resources of the United States, and affords possibly our only opportunity for developments of the magnitude of some of the multimillion kilowatt plants now under construction in the Soviet Union, thus appearing to offer great potentiality as a basis for economic development of Alaska.

The report deals in turn with basic physical data (climate, glaciers, lakes, permafrost, relation of geology to water supplies, occurrence of water, quality of water); irrigation; hydroelectric power; industrial and municipal water; fish and wildlife in relation to water-resource development; recreation.

Relation of geology to water supplies is summarized as follows. The rocks in the southeastern region are generally hard, relatively impervious masses of volcanic or dense sedimentary rock. The chances of developing large ground-water supplies are meager. The impervious nature of the rocks, slight or absent soil cover to absorb precipitation, and the steep relief account for the high ratio of stream runoff to precipitation.

The hydrologic pattern in the coastal region S. of the Alaska Range is quite different. Ground water is available from the wide glacial deposits filling the major valleys. These deposits are readily recharged by local precipitation and probably, to some extent, by runoff from glaciers in the higher more impervious volcanic peaks and ranges. Overland flow and streamflow are tempered by the low grades of the glacial valleys. Near the coast the land often is so flat that muskeg bogs are common.

The hydrology of the Copper River system is peculiar in that near its mouth the river cuts through a rock slot. In this respect the basin is somewhat like a teapot - it can hold a large volume of water below the spill point. Perhaps this phenomenon accounts for the high salt content of the ground water. Near the ocean, precipitation may carry appreciable quan-

tities of sea salts. If, during its history, the Copper River had trouble cutting through the hard rock in the lower reaches, some of the valley might have been flooded and the salts concentrated in the remaining water by evaporation.

In the interior region broad stream valleys have been gouged out of hard rock by glaciers and later filled with debris as the glaciers melted and retreated. These intermontane valleys contain large quantities of ground water. In wide areas of the Tanana, Yukon, and Kuskokwim valleys, the glacial alluvium has very little clay and till; hence, the permeability is high. The nonglaciated areas probably have less ground-water potential, but much of this area is too swampy or otherwise unattractive to be of immediate concern.

Streams, many of which rise from glaciers, are recharged by ground-water inflow from the permeable valley fill. This lends stability of low flow in the streams. The glacial streams are fouled with glacial flour.

N. of the Brooks Range, geology has little effect on water supplies. Permafrost is present to the exclusion of true ground water except in the alluvium of Colville River. During the winter, shallow lakes and small streams are frozen, but in summer it is possible to develop a little ground water from the thin skin of permafrost melt.--From p. iii, 3-4.

3-4209. Cederstrom, D. John. GROUND-WATER HYDROLOGY IN ALASKA (In: Raasch, Gilbert O., ed. Geology of the Arctic. . . : v. 2, p. 1014-1019, Toronto, University of Toronto Press, 1961)

Systematic studies of ground-water hydrology in Alaska began in 1947. Intensive studies were carried out in Fairbanks, Anchorage, and the Matanuska valley. Localized studies have been made elsewhere - in Kotzebue, the Pribilof Islands, and Bethel, in particular. Work in this field continues today.

The Tanana valley, in which Fairbanks is located, with its gravelly fill was found to be one of the most prolific sources of ground water in the world. In this area permafrost is a minor problem in developing ground water, as is high Fe content in the water. In Anchorage and the Matanuska Valley ground water occurs sporadically in glacial deposits, but many wells have yielded water copiously. Many failures are known, however, in part because of poor construction. Municipal supplies of ground water have been developed at Fairbanks, Anchorage, and Palmer.

Alaska N. of southeastern Alaska may be characterized as an area where great alluvial valleys contain much ground water. Northward, however, permafrost becomes more and more of a problem. Possibilities of development of water from hard rock are little known.

The negative results of drilling at Kotzebue and the more favorable results of investigations in the Pribilof Islands and at Bethel are briefly discussed. --Auth.

3-4210. Gregg, Dean O., and others. PUBLIC WATER SUPPLIES OF COLORADO, 1959-60. Prepared by the U. S. Geological Survey in cooperation with the Colorado State University Agricultural Experiment Station: 128 p., 5 figs., 5 tables, Fort Collins, Colorado, Colorado State University, June 1961, 8 refs.

This report presents and summarizes statistical data collected from 297 communities. A subsequent report will describe the management and operational aspects of public water supplies and will suggest methods for better utilizing ground-water reservoirs to expand and regulate municipal water supplies.

This report describes the source, treatment, and volumes of water used for public supplies by Colorado's cities and towns. Previously, information on the water supplies of many of the smaller cities and towns was not readily available. A comprehensive study of the complex water systems in the Denver metropolitan area and the large cities along the Front Range is beyond the scope of this project. In general, these municipalities already have detailed information and plans for future expansion. Also included are discussions of the state's surface-water and ground-water resources as related to public water supplies, and a discussion of the chemical quality of water related to uses.

This report should be useful to industries considering plant sites in the state; to municipalities that wish to evaluate their supply by comparing their supply with others; to federal, state, and local planning groups, and to health officials, civic betterment organizations, and other individuals and groups who have a specific interest in the water resources of the state.--From introd.

3-4211. Jenkins, Edward D. RECORDS, LOGS, AND WATER-LEVEL MEASUREMENTS OF SELECTED WELLS AND TEST HOLES AND CHEMICAL ANALYSES OF GROUND WATER IN FOUNTAIN, JIMMY CAMP, AND BLACK SQUIRREL VALLEYS, EL PASO COUNTY, COLORADO: Colorado, Water Conserv. Board, Basic Data Rept. no. 3, Ground-Water Ser., 25 p., fig., 2 maps (in pocket), 5 tables, 1961.

This report is intended to serve 2 purposes: 1) to make available to the public basic ground-water data useful in planning and studying water-resources development and 2) to supplement an interpretive report that will be published later.

The records were collected during the period 1954-1960. Those from Fountain and Jimmy Camp valleys were collected as a part of a comprehensive investigation of the ground-water resources. Those from Black Squirrel Valley were collected during an inventory of wells made to show the extent of development. Both the collection of records and the investigation were done by the U.S. Geological Survey chiefly in cooperation with the City of Colorado Springs and the Fountain Valley Water Users Association. The Colorado Water Conservation Board cooperated in part of the data collection and in the preparation of this report. The interpretive report by Edward D. Jenkins will be published as a U.S. Geological Survey Water-Supply Paper entitled "Ground Water in Fountain and Jimmy Camp Valleys, El Paso County, Colo."

This report is most useful in predicting conditions likely to be encountered when drilling a new well. The person considering the new well can spot the proposed site on the maps and examine the records of nearby wells. From table 2 he can determine what success his neighbors may have had; from table 3 he may determine the type of materials likely to be encountered; from table 4 he may note the historic fluctuations and trends of water levels in the vicinity; and from table 5 he may determine whether the quality of water is likely to be suitable for its intended use. The information in tables 2-5 is representative chiefly of shallow water-bearing formations; table 1 may be useful in determining whether it is practical to drill deeper in search of water.

The report also is useful when repairing wells, determining the extent of geologic formations, and planning large-scale developments of water supply. These and other uses of the report will be facilitated upon release of the interpretive report.--From introd.

3-4212. McLaughlin, Thad G., and others. RECORDS AND LOGS OF SELECTED WELLS AND TEST HOLES, AND CHEMICAL ANALYSES OF GROUND WATER FROM WELLS AND MINES, HUERFANO COUNTY, COLORADO: Colorado, Water Conserv. Board, Basic Data Rept. no. 4, Ground-Water Ser., 26 p., fig., map (in pocket), 5 tables, 1961.

This report is intended to serve two purposes: 1) to make available to the public basic ground-water data useful in planning and studying water-resources development and 2) to supplement an interpretive report that will be published later.

The records were collected during the period 1949-1951 as a part of the investigation of the geology and ground-water resources of Huerfano County made by the U.S. Geological Survey in cooperation with the Colorado Water Conservation Board. The interpretive report by Thad G. McLaughlin will be published as a U.S. Geological Survey Water-Supply Paper entitled "Ground-Water Resources of Huerfano County, Colo."

The well and test-hole numbers in the tables indicate the locations of wells shown on the map. The numbering system is based on the U.S. Bureau of Land Management system of land subdivision.

This report is most useful in predicting conditions likely to be encountered when drilling a new well. The person considering the new well can spot the proposed site on the map and examine the records of nearby wells. From table 2 he can determine what success his neighbors may have had; from table 5 he may determine the type of materials likely to be encountered; and from table 3 he may determine whether the quality of water is likely to be suitable for its intended use. Table 1 may be useful in determining whether it is practical to drill deeper in search of water.

The report also is useful when repairing wells, determining the extent of geologic formations, and planning large-scale developments of water supplies. These and other uses of the report will be facilitated upon release of the interpretive report.--From introd.

3-4213. Moulder, Edward A. OCCURRENCE OF GROUND WATER IN THE OGALLALA AND SEVERAL CONSOLIDATED FORMATIONS IN COLORADO: Colorado, Water Conserv. Board, Circ. no. 5, 8 p., Dec. 1960, ref.

The aquifers herein discussed differ from the alluvial aquifers along the principal streams. Withdrawals from these aquifers have little effect on the surface-water resources of Colorado compared to those from the alluvial aquifers of the South Platte, Arkansas, and San Luis valleys. The Ogallala formation of Pliocene age receives little recharge from streams and contributes little water to streams in Colorado. The perennial streams are in contact with the Ogallala and the principal consolidated water-bearing formations in Colorado only where they cross the outcrops of the formations; the contact area is small compared to the areal extent of the aquifers. Therefore, in most areas, it may be possible, from a practical standpoint, to satisfactorily develop and manage the ground-water resources of these aquifers independent of the surface water.

Deposits of the Ogallala formation make up the surface of the High Plains and form the aquifer. However, a part of the Ogallala formation is overlain by younger windblown deposits generally less than 50 ft. thick. The Ogallala consists chiefly of sand and gravel, although it contains numerous beds of finer grained material consisting of clay, silt, cemented sand, and limestone. In a few places the formation is more than 400 ft. thick, but more generally it ranges in thickness from 200 to 300 ft. From one-third to one-half of the material is saturated with ground water.

The Ogallala formation has not been extensively developed for water in Colorado. However, enough wells have been drilled to prove that it is capable of supplying large quantities of water which can be used for irrigation. A recent estimate indicates that about 400 wells were being used for irrigation in 1960; the number has been increasing each year.

The consolidated formations in Colorado generally are capable of yielding much less water per well than the unconsolidated formations. Few areas are underlain by rocks capable of yielding more than 300 g.p.m. (gallons per minute) per well. A few local areas have wells that yield more than 1,000 g.p.m., but throughout most of the state well yields generally range from 5 to 50 g.p.m. At least three-fourths of the state is underlain by materials capable of supplying sufficient water to wells for domestic and stock use, although in some places the water is of poor quality. Where thick alluvial deposits overlie the consolidated formations, the alluvium generally is the most productive aquifer.--From auth., p. 1-3.

3-4214. Menke, C.G., and others WATER RESOURCES OF HILLSBOROUGH COUNTY, FLORIDA: Florida, Geol. Survey, Rept. Inv. 25, 101 p., 56 figs., 6 tables, 1961.

Hillsborough County is near the W. coast of central Florida and is composed of 1,040 sq. mi. of land. This report is an evaluation of the basic hydrology of the county and of some of the major factors that affect the available fresh-water supply.

An average of 1,400 m.g.d.(million gallons per day) of fresh water is potentially available in the county - 1,000 m.g.d. of surface water and 400 m.g.d. of ground water. This is enough to supply 1,250,000 people using 1,100 g.p.d. (gallons per day) per capita, if all the flood waters could be stored for use. The fresh-water supply is composed of about 2,500 m.g.d. of rainfall on the county, of 300 m.g.d. surface-water inflow, and of 100 m.g.d. ground-water inflow to the county. About 1,500 m.g.d. is returned to the atmosphere by evapotranspiration.

Three rivers, the Hillsborough, Alafia, and Little Manatee rivers, have an average combined flow of 508 m.g.d. and drain about 70% of the county. The average flow of the Hillsborough River is 173 m.g.d., of which about 23 m.g.d. is used by the city of Tampa for its municipal supply. The average flow of the Alafia River is 220 m.g.d. and of the Little Manatee River is 115 m.g.d. The observed minimum flow of the Hillsborough River was 31 m.g.d., of the Alafia River was 4.3 m.g.d., and of the Little Manatee River was 0.8 m.g.d. The flow of the Alafia River is used to dispose of industrial wastes, and the flow of the Little Manatee River is wasted to the sea.

Water may be obtained from 3 aquifers. The nonartesian aquifer, composed of surface sands, yields up to 200 g.p.m. (gallons per minute) per well. The shallow artesian aquifer, composed of limestone and

sand beds in the Hawthorn formation of Miocene age, yields up to 500 g.p.m., and the principal artesian aquifer, composed of limestones of Tertiary age lying below the Hawthorn formation, yields up to several thousands g.p.m. per well.

The coefficient of transmissibility of the principal artesian aquifer ranges from about 75,000 to 220,000 gallons per day per foot, and the coefficient of storage from 0.00005 to 0.002 gallons per square foot per foot. The coefficient of leakage, in gallons per day per square foot under a unit gradient divided by the thickness in feet of the confining beds above and below the aquifer, is 0.002 at the site of the Tampa well field 6 mi. W. of Plant City.

Most of the 67 m.g.d. of ground water used in the county is derived from the principal artesian aquifer. Movement in the aquifer is primarily through the zones of high permeability that are associated with joints and faults. Locally, these zones behave as aquifers when they are pumped or recharged at high rates. The aquifer is recharged through sinkholes and through the sands and clays that overlie it, and large amounts of water are discharged from the aquifer to streams in the northern half of the county and to the bay.

The water level in the nonartesian aquifer is generally within a few feet of the land surface. Water levels in the shallow artesian aquifer are erratic areally. The piezometric surface of the principal artesian aquifer is higher than 100 ft. in the northeastern part of the county and generally slopes toward Tampa Bay. Troughs in the piezometric surface extend inland, indicating that water is discharged from the aquifer into the Hillsborough and Alafia rivers.

Dissolved materials of surface waters was generally less than 250 p.p.m. (parts per million) in the county. Notable exceptions are the Alafia River, with an average dissolved-materials concentration of 292 p.p.m., and a maximum of 658 p.p.m., and Sulphur Springs with an average of 500 p.p.m. and a maximum of more than 1,000 p.p.m. Most of the streams have dissolved materials of less than 100 p.p.m. but contain colored organic materials leached from vegetation.

Water in shallow aquifers appears to have less than 100 p.p.m. dissolved materials in most of the county and may contain organic color in quantities ordinarily less than those found in streams. Ground water found between depths of 100 and 200 ft. generally had less than 500 p.p.m. of dissolved materials except in the coastal areas.

Where the piezometric surface is more than 30 ft. above sea level, ground-water supplies containing less than 500 p.p.m. of dissolved materials may be obtained at a depth below sea level not exceeding 40 times the elevation of the piezometric surface above sea level. Where the elevation of the piezometric surface is less than 30 ft., the concentration of dissolved materials varies erratically with both depth and location from about 170 to more than 11,000 p.p.m. In the Ruskin area, the concentration and character of dissolved materials changes with the lowering of water levels.

Variations of rainfall, streamflow, ground-water levels, and concentrations of dissolved material are given in the report.--Auth.

3-4215. U.S. Congress, Senate, Select Committee on National Water Resources. WATER RESOURCES ACTIVITIES IN THE UNITED STATES. WATER RESOURCES OF HAWAII: U.S. 86th Congress, 2d sess., 1960, Committee Print no. 20, 12 p., 3 figs., 2 tables, Washington, D.C., U.S. Govt. Print. Off., 1960.

In general, the islands receive abundant rainfall, but because of unequal areal distribution related to the effects of mountains and seasonal variations, there are some inhabited areas with recurring water shortages. Many fertile areas could produce crops if water were supplied. In the descriptions of occurrence, availability, use, and shortages of water, particular problem areas on each of the islands are treated in detail. Solution of water problems is mainly a matter of economics. The report deals in turn with precipitation; hydrologic effects of island geology; streamflow; ground water; quality of water; use; water problems on Hawaii, Maui, Lanai, Oahu, and Kauai; major problems; fish and wildlife; recreation.

Porosity and permeability are such, in general, that during periods of moderate rainfall intensity there may be runoff only in the areas of high elevation and extremely steep slopes. As the streamflow progresses down channel getting further and further from the area of moderate rainfall (rainfall intensities decrease with decreasing altitude) more and more of the water in the channel infiltrates through the channel walls to become part of the local ground water. About two-thirds of the area of the islands fails to produce streamflow in usable quantities.

Where tight soils or "tight" lava flows of little slope occur at high altitudes, mountain top swamps may exist. There may be no free water as in a true swamp, but the soil in these mountaintop swamps may be saturated and provide a significant reservoir for providing perennial seepage to streams. Alakai swamp on Kauai, the largest such swamp in the islands, covers more than 6 sq. mi. and feeds the Waimea River.

Because of the high permeability of the lava material forming the islands, conditions are optimum for abundant ground-water supplies. The bulk of these supplies occur as basal water floating on salt water, but local geologic conditions may cause other types of ground water to occur. These types - dike impounded, perched water, and shallow ground water are described in more detail in the section on ground water.--From p. 1, 4-5.

3-4216. Rodis, Harry G. USE OF WATER-WELL DATA IN INTERPRETING OCCURRENCE OF AQUIFERS IN NORTHEASTERN LYON COUNTY, MINNESOTA: Geol. Soc. America, Bull., v. 72, no. 8, p. 1275-1278, 2 figs., Aug. 1961, ref.

In northeastern Lyon County the areal distribution of aquifers of Cretaceous age determined from well-bottom altitudes suggests a series of interbedded sandstones striking northwestward and overlapping one another to the NE. Probably the numerous thin sandstone aquifers in the area were deposited near the flanks of a Precambrian granite "high" area by a transgressing Late Cretaceous sea.--Auth.

3-4217. Schneider, Robert, and Harry G. Rodis. AQUIFERS IN MELT-WATER CHANNELS ALONG THE SOUTHWEST FLANK OF THE DES MOINES LOBE, LYON COUNTY, MINNESOTA: U.S. Geol. Survey, Water-Supply Paper 1539-F, 11 p., 8 figs., 1961, 3 refs.

During the Cary and Mankato substages of Wisconsin glaciation the Des Moines lobe advanced southeastward through the broad lowland of the Minnesota River valley of southwestern Minnesota, and thence southward to central Iowa.

Among the most prominent topographic features in Lyon County, are 5 southeastward-trending end moraines, 2 of which are associated with and parallel to belts of surficial outwash that are approximately half a mile to a mile wide. Test drilling indicated that one of the belts of outwash is underlain by a complex system of buried meltwater channels. The other is the upper part of a series of deposits in an incised channel. The channels are filled with till, glaciolacustrine deposits, and outwash, which includes permeable deposits of water-bearing sand and gravel.

Associated with the surficial meltwater channels is a pronounced southeastward-trending linear drainage pattern. By studying the lineation of streams and lakes, analyzing the available water-well data, and drilling test holes, several elongate deposits of buried outwash having little or no topographic expression were located. The long axes of the deposits are generally parallel to the lineation of the drainage and the end moraines.

The meltwater channels in Lyon County trend southeastward because the flank of the ice sheet was confined by a landmass that sloped to the NE. Similiar buried channels may be present elsewhere along the SW. flank of the Des Moines lobe. If so, they probably can be located by the methods described. --Auth.

3-4218. Nevada Water Conference, 14th, Carson City, 1960. PROCEEDINGS: 104 p., map, graphs, tables, 1960.

This conference, held Sept. 29-30, 1960, was sponsored by the State Dept. of Conservation and Natural Resources and the Nevada State Reclamation Association. The following papers were presented:

Some New Programs of the U. S. Geological Survey, by J. V. B. Wells.
Evaluation of Tracers in Ground-Water Problems, by Donald R. Nielson.
Reclamation at the Crossroads, by LaSelle E. Coles.
Chemicals for Agricultural Water Conservation, by Lloyd E. Meyers.
Surface Neutron Probe for Soil Moisture, by C. M. van Bavel.

Included also are brief reports of various federal government and state agencies: Fish and Game Commission; Bureau of Reclamation; Soil Conservation Service; U. S. Army Corps of Engineers; U. S. Geological Survey; U. S. Weather Bureau; Federal Power Commission; U. S. Forest Service; Humboldt River Research Study; Bureau of Land Management; Cooperative Snow Surveys; Division of Forestry; Division of Water Resources, etc.

Reports dealing with ground-water geology are as follows:

Cooperative Ground-Water Investigations in Nevada, by O. J. Loeltz, p. 74-76.
Geological Progress, Humboldt River Research Project, by James I. Gimlett, p. 101-104.

--A. C. Sangree.

3-4219. Zones, C. P. GROUND-WATER POTENTIALITIES IN THE CRESCENT VALLEY, EUREKA AND LANDER COUNTIES, NEVADA: U. S. Geol. Survey, Water-Supply Paper 1581, 50 p., 6 figs., pl. (in pocket), 5 tables, 1961, 12 refs.

The Crescent Valley is an intermontane basin in Eureka and Lander counties, just S. of the Humboldt River in N.-central Nevada. The average annual precipitation upon the floor of the valley is probably less than 7 in. of which only a little more than 1 in. normally falls during the growing season (from June through Sept.). Irrigation is essential to agricultural development. In 1956 the total pumpage from wells in the valley was 2,300 acre-ft.

The valley is a basin in which has accumulated a large volume of sediments eroded and transported by streams from the surrounding mountains. The deepest wells have penetrated only the upper 350 ft. of these sediments, which may be as much as several thousand feet thick. Because this valley fill is saturated practically to the level of the valley floor, the total volume of ground water in storage amounts to millions of acre-feet. In practically all wells drilled to date, the water has been of a quality satisfactory for irrigation and domestic use.

The amount of water that can be developed and used perennially is far smaller than the total in storage and is dependent upon the average annual recharge to the ground-water reservoir. This recharge comes principally from streams, fed largely by snowmelt, that drain the higher mountains. The average annual recharge to the valley fill is estimated to be about 13,000 acre-ft. This natural supply, which is largely consumed by native vegetation on the valley floor, consitutes a perennial supply for beneficial use only to the extent that the natural discharge can be reduced. In time, much of the natural discharge can probably be salvaged, if it is economically feasible to pump ground water after water levels have been lowered as much as 100 ft. in the areas that now appear to be favorable for the development of irrigation supplies.

In 5 wells in the phreatophyte area, where the water table is within 3-8 ft. of the land surface, the trends in water level have paralleled those in precipitation - downward during the dry years 1952-1955, upward in wetter 1956 and 1957, and as high in 1957 as at any time since 1948. In most wells there is also a seasonal fluctuation of 1-3 ft. from a high in the spring to a low in the fall. There is no evidence to date that pumping has lowered the water table in the area of natural discharge. It is to be noted that all 9 of the large production wells are at the edge of the area of natural discharge.

The most favorable area for the development of ground water appears to be the W.-central part of the Crescent Valley, from the Indian Creek fan northward to about the latitude of Corral Canyon. All but one of the large wells already developed are in this area. The favorable areas on the E. side of the valley are likely to be at the toes of the fans of the larger flowing streams.

It is believed that any effect of ground-water development in Crescent Valley on the flow of the Humboldt River will be insignificant, because underflow from the valley to the Humboldt River probably is very small and there is rarely any surface flow from the valley.--From auth.

3-4220. Zones, C. P. GROUND-WATER RECONNAISSANCE OF WINNEMUCCA LAKE VALLEY, PERSHING AND WASHOE COUNTIES, NEVADA: U. S. Geol. Survey, Water-Supply Paper 1539-C, 18 p., map, table, 1961, 7 refs.

Winnemucca Lake valley is an intermontane valley in western Nevada. The valley trends N. and is bordered on the E. by the Nightingale Mountains and the Selenite Range and on the W. by the Lake Range. The mountains were uplifted and tilted eastward as a result of faulting along their W. sides.

Material eroded from the mountains has accumulated in the valley. In the northern part of the valley older alluvium of Quaternary age is exposed in alluvial fans - large ones at the base of the Selenite Range and small ones at the base of the Lake Range. Elsewhere in the valley the material of the piedmont slopes has been reworked by currents and waves of Lake Lahontan into beach terraces and gravel spits. Younger sediments deposited in Winnemucca Lake overlie the sediments of Lake Lahontan downslope from the base of the piedmont.

Winnemucca Lake was dry about 1840, began to fill shortly thereafter, and then contained water until about 1945. In 1882 the lake had a maximum depth of 87 ft. Exposed sediments deposited in Winnemucca Lake consist largely of clay and silt, except at the S. end of the valley, where coarse sand and gravel mantle the surface.

The sediments of Winnemucca Lake are generally nearly impermeable. On the other hand, the coarse-grained sediments of the Lake Lahontan shore features may transmit water readily, if they occur within the zone of saturation. The older alluvium exposed in fans at the N. end of the valley may yield moderate quantities of water to wells under favorable conditions, but the depth to ground water probably is greater than 100 ft.

Ground water in the valley is recharged mainly from precipitation that runs off from the bordering mountain ranges. Lesser amounts of recharge are received by ground-water inflow through a gap at the S. end of the valley, and from precipitation on the valley floor.

Ground water is discharged by direct evaporation from the large mud flat that occupies most of the valley floor, by springs, and by transpiration by phreatophytes. From crude estimates of the average annual recharge and discharge it is concluded that the ground-water supply of the valley is about 5,000 to 10,000 acre-ft. per year.

Ground water beneath the valley floor is highly mineralized. Even though wells drilled into the material underlying the piedmont slopes may tap water of good chemical quality, large withdrawals from such wells on a long-term basis may reverse the hydraulic gradient and cause water of poor chemical quality to move from the central part of the valley to the pumped wells.--Auth.

3-4221. Benz, Leo C., and others. GROUND-WATER INVESTIGATIONS IN A SALINE AREA OF THE RED RIVER VALLEY, NORTH DAKOTA: Jour. Geophys. Research, v. 66, no. 8, p. 2435-2443, 6 figs., table, Aug. 1961, 19 refs.

Investigations in a saline area of the Red River Valley in North Dakota indicate that salt-affected soils are caused by high water tables, poor drainage conditions, and saline artesian waters. A 3-year study conducted in a 200-sq. mi. area shows that rainfall was a major contributor to the high and fluctuating water table. Chemical composition of the ground waters indicate that the Dakota sandstone artesian waters are the most likely source of salt.--Auth.

3-4222. Ohio, Division of Water. WATER INVENTORY OF THE OHIO BRUSH, EAGLE, STRAIGHT AND WHITEOAK CREEK BASINS: Its: Ohio Water Plan Inventory, Rept. no. 15, 49 p., 18 pls., (1 in pocket), 19 tables, 1960.

The third in a series of studies planned to cover resources, problems, and possible solutions in 18 major drainage areas. The first 2 reports were listed as GeoScience Abstracts 1-2589 and 2-3526. The text discusses the area and its economy; surface- and ground-water supply, quality, pollution, recreation; flood problems and watershed management (soils, drainage and erosion problems, soil conservation); major needs and possible solutions.

Consolidated rocks include shales, limestones, dolomites, and a small amount of sandstone. They are overlain by thin deposits of unconsolidated rocks, rarely thicker than 70 ft., except in the flood plain of the Ohio River. Northern and western portions of the area are covered by surface deposits of glacial drift. Unconsolidated surface deposits in the southern and eastern portions lie outside the glaciated area. Both glacial and nonglacial surface deposits are composed chiefly of clay and yield little or no water to wells.

Conclusions are that water resources are more than adequate for any foreseeable need, but they require development by wells, reservoirs, and pipelines. The underground supply along the Ohio River is generally ample and free of pollution. Surface and underground waters of the area, although hard, are usable for most purposes after limited treatment. Many maps, graphs, and tables facilitate interpretation of the data.--A. C. Sangree.

3-4223. Halberg, Henry N., and others. WATER RESOURCES OF THE PROVIDENCE AREA, RHODE ISLAND: U. S. Geol. Survey, Water-Supply Paper 1499-A, 50 p., 16 figs., col. geol. map (in pocket), scale 1:125,000, 8 tables, 1961, 48 refs.

The Providence area, as the term is used in this report, consists of 320 sq. mi. in northeastern Rhode Island. The city of Providence is near its center. The largest ground-water supplies are in the glacial outwash deposits of sand or gravel. Municipal and industrial wells in these deposits commonly yield between 10 and 1,000 g.p.m. (gallons per minute). A gallon or 2 of water per minute can be obtained from wells tapping the widely distributed deposits of glacial till. Water can also be obtained from wells tapping the underlying bedrock, which is sedimentary, igneous, and metamorphic. Municipal and industrial wells tapping bedrock yield from 5 to 200 g.p.m. Ground water in the Providence area is satisfactory for most purposes after minimum treatment, except for the Fe and Mn content and hardness of water from some wells. Ground-water temperature ranged from 51° to 60°F. and averaged about 56°F.

Unlimited quantities of saline water can be obtained from Narragansett Bay. [Average flow of the Blackstone Branch, Woonasquatucket, and Pawtuxet rivers is noted.]...

Water from streams in the Providence area is generally of satisfactory chemical quality, except for the high Fe and Mn content and color of some water. Municipal and industrial wastes discharged into some of the larger streams make the water unsuitable for use without considerable treatment. The water is mostly soft, slightly acid, and contains less than 100 p.p.m (parts per million) of dissolved solids.

The major public water-supply systems of the area obtain most of their water from reservoirs on small streams. In 1954, about 60% of the 110 m.g.d. of fresh water withdrawn for all purposes was obtained from public-supply systems, about 39% from private industrial systems, and less than 1% from private domestic systems. Of the total amount, 96 m.g.d. was obtained from surface-water sources and 14 m.g.d. was drawn from wells. An additional 359 m.g.d. of saline water from estuaries was used al-

most entirely for condenser cooling in the generation of thermoelectric power.

Many additional water-supply systems can be developed in the Providence area. Because of the discharge of industrial and municipal wastes, quality rather than quantity of water is likely to limit additional municipal and industrial development of water supplies from the larger streams. Except for this pollution and the occurrence of Fe, Mn, and color in some water, the quality of ground and surface water in the Providence area is fair to good. Moderate to large quantities of ground water may be obtained in many places from the glacial outwash along the river channels, in the buried preglacial valleys, from other places where there are water-bearing deposits of sand and gravel of appreciable thickness, or where pumping induces recharge of aquifers by surface water.--From auth.

3-4224. Walker, Ian R. SHALLOW OUTWASH DEPOSITS IN THE HURON-WOLSEY AREA, BEADLE COUNTY, SOUTH DAKOTA: South Dakota, State Geol. Survey, Rept. Inv. no. 91, 44 p., 8 figs., 2 tables, 1961, 6 refs.

The Huron-Wolsey area is in E.-central South Dakota in the central part of the James basin of the Central Lowlands physiographic province. The area occupies about 250 sq. mi. and is drained southward by the James River.

Pierre shale of Cretaceous age forms the bedrock of the area, and is mantled by an average of 75 ft. of Pleistocene glacial deposits.

About 73 sq. mi. of the Huron-Wolsey area is underlain by buried glacial outwash deposits. The deposits are 30 or more ft. thick in about 20% of the area, and the sand and gravel is interfingered with clay and glacial till to such an extent that the amount of water available for irrigation and domestic use cannot be computed accurately.

Irrigation pumping in the area in the summer of 1960 caused the artesian head of water in the buried outwash deposits to decline as much as 13 ft.

The quality of this shallow water for irrigation is fair to poor.--Auth.

3-4225. Dyer, C. F. GEOLOGY AND OCCURRENCE OF GROUND WATER AT JEWEL CAVE NATIONAL MONUMENT, SOUTH DAKOTA: U.S. Geol. Survey, Water-Supply Paper 1475-D, p. 139-157, 2 maps, 1961, 2 refs.

Jewel Cave National Monument occupies 2 sq. mi. of a broad plateau of sedimentary rocks in western Custer County and is at an altitude of about 5,400 ft. above mean sea level. The sedimentary rocks that constitute the plateau range in age from Cambrian to Pennsylvanian. Rocks of Silurian and Devonian age are absent. The presence of rocks of Ordovician age has not been established definitely, but they may be represented by 10 ft. of sandstone directly beneath the Englewood limestone of Mississippian age. The sedimentary formations are underlain by schist of Precambrian age.

Study of outcrops in the vicinity of the monument confirms the existence of a fault about 1,500 ft. N. of the entrance to Jewel Cave. The fault trends generally E.-W. across the monument and has a displacement of about 120 ft. about 1 mi. W. of the entrance to the cave. The effect of the fault on the occurrence of ground water near the cave is not known.

In addition to the spring that furnishes the present (1959) water supply for the facilities at Jewel Cave, 3 springs outside the monument were visited during the study. Combined yield of the 3 springs is less than 2 g.p.m. (gallons per minute).

A single test well indicates that the monument at the well site is underlain by 665 ft. of limestone, dolomite, and sandstone of Paleozoic age and an undetermined thickness of quartz-biotite schist of Precambrian age. Pumping tests using a cylinder pump indicate that the test well is capable of producing 15 to 18 g.p.m. for a short time from 2 zones of sandstone below the Englewood limestone. These sandstones are believed to present the best possibilities for development of a permanent water supply at the monument.--Auth.

3-4226. Jorgensen, Donald G. GEOLOGY AND SHALLOW GROUND WATER RESOURCES OF THE MISSOURI VALLEY BETWEEN NORTH SIOUX CITY AND YANKTON, SOUTH DAKOTA: South Dakota, State Geol. Survey, Rept. Inv. no. 86, 59 p., 6 figs., 2 pls. (in pocket), 6 tables, 1960, 21 refs.

The North Sioux City-Yankton area of southeastern South Dakota is drained by the Missouri River and its tributaries the Big Sioux, the Vermillion, and the James rivers.

Precambrian unnamed granite and Sioux quartzitic sandstone form the basement rocks of the area; they are overlain by lower Paleozoic and Cretaceous sedimentary rocks and by Pleistocene deposits that include drift of Kansan(?), Illinoian(?), and Wisconsin ages.

In 1958 an estimated 1,375 billion gallons of shallow ground water occupied the glacial outwash deposits, which contain 22 billion cu. yd. of sand and gravel. In addition, in 1958 an estimated 875 billion gallons of shallow ground water occupied 13 billion cu. yd. of sand in alluvial deposits. The quality of this ground water is satisfactory for human consumption, for irrigation, and for industrial use.--Auth.

3-4227. Walker, Ian R. SHALLOW GROUND WATER RESOURCES IN THE WAGNER AREA, CHARLES MIX AND DOUGLAS COUNTIES, SOUTH DAKOTA: South Dakota, State Geol. Survey, Rept. Inv. no. 90, 53 p., 12 figs., 2 maps (in pocket), 5 tables, 1961, 5 refs.

The Wagner area is in southeastern South Dakota in the extreme western part of the James basin of the Central Lowlands physiographic province. The area occupies about 250 sq. mi. and is drained southward by Choteau Creek.

Glacial deposits as much as 350 ft. thick fill an ancient SW.-trending pre-Pleistocene stream valley, which drained the Wagner area. The valley was carved in Pierre shale, Niobrara chalk, and Carlile shale, all of Cretaceous age.

The Pleistocene deposits in the area include 3 glacial outwash bodies. A discontinuous surface outwash deposit along Choteau Creek is variable in composition and thickness and yields small quantities of water to domestic and stock wells. A second sand and gravel outwash deposit, averaging 30 ft. thick, is buried beneath about 65 ft. of glacial drift. No wells are known to draw water from this deposit. The third and lowest glacial outwash deposit averages 50 ft. thick through 90% of the area, and supplies water to nearly all the wells.

The lower outwash deposit contains about 2,100,000 acre-ft. of water, and yields 200 to 900 g.p.m. to 18-in. irrigation wells that are 150 to 200 ft. deep. All wells tapping this lower outwash deposit are artesian

wells, the head everywhere exceeding 120 ft. above the sand. Wells along Choteau Creek, which were flowing about 5 g.p.m., stopped flowing in July 1960 when a total of 98.8 acre-ft. of water had been pumped for irrigation purposes during that summer.

This lower buried outwash deposit is recharged by Lake Andes. The water from the lower deposit should not be used for irrigation because of its poor chemical quality.--Auth.

3-4228. Texas, Agricultural and Mechanical College System, Water Research and Information Center. PROCEEDINGS OF THE SIXTH ANNUAL CONFERENCE ON WATER FOR TEXAS: 74 p., illus., diags., graphs, 1960.

The conference was held at the Memorial Student Center at the A. & M. College of Texas, College Station, Sept. 7-9, 1960. Papers are listed below:

Present and Potential Water Requirements for the State of Texas, by John J. Vandertulip.
Estimation of Future Municipal and Industrial Water Requirements, by Uel Stephens.
Some Aspects of Future Agricultural Water Use, by William F. Hughes.
Recreational Water Needs, by Fred B. Lifton.
Water for the Future, by A. L. Miller.
Storage of Water in Reservoirs, by Forrest O. Swiggart.
Chemical Pollution of Ground Water, by Ed L. Reed.
The Requirement for Freshwater in a General Plan for Multiple Development of the Marine Bays, by Howard T. Odum.
Conservation as a Means of Providing Water for the Future, by William O. Trogdon.
Evaporation Loss Reduction, by W. D. Harris and W. W. Meinke.
How Can We Meet Our Water Needs?, by C. R. Marks.
The Edwards Underground Water District, by McDonald D. Weinert.
Recreation's Case in the Conflict for Water, by Louis S. Clapper.
Resolving Conflicts Apparent to the Board of Water Engineers, by Durwood Manford.
Resolving Conflicts Apparent to the U. S. Study Commission - Texas, by Charles D. Curran.
Resolving Water Conflicts in General, by J. E. Sturrock.

3-4229. Wilmoth, Benton M., Jr. PARTICLE-SIZE AND PERMEABILITY STUDIES OF THE QUATERNARY ALLUVIUM IN KANAWHA COUNTY, W. VA.: West Virginia Acad. Sci., Proc., v. 31/32, p. 174-179, 2 figs., table, 1959-1960, 4 refs.

Intergranular spaces in the Pleistocene and Recent alluvium of the Kanawha and Elk rivers contain little or no cementing materials which would tend to reduce permeability. Much of the alluvium is poorly sorted, however, which does reduce permeability. It is capable of yielding only moderately large quantities, in places to 100 gallons per minute, to wells. Induced infiltration of river water may be practicable.--M. Russell.

3-4230. Meyer, Gerald. CHEMICAL COMPOSITION OF FRESH GROUND WATER IN WEST VIRGINIA: West Virginia Acad. Sci., Proc., v. 31/32, p. 162-166, 2 figs., table, 1959-1960.

Throughout much of West Virginia the chemical content of the ground water and the rocks with which it has been in contact are interrelated, and it is possible to classify the water into general categories by the principal cationic and anionic constituents of the dissolved mineral matter. In the coal-bearing rocks of the Allegheny Plateau region of central and western West Virginia the ground water ranges from hard calcium bicarbonate water near the land surface to soft sodium bicarbonate water at moderate depth and saline brine in the deeper zones. In the eastern panhandle counties the ground water is highly variable owing to the many different strata.--M. Russell.

12. MINERAL DEPOSITS

See also: Geologic Maps 3-3946; Geophysics 3-4130; Mineralogy 3-4158.

Correction: GeoScience Abstracts 3-3452 in v. 3, no. 10, Oct. 1961, should read Florida, Geol. Survey, Bull 42, not Bull. 43.

3-4231. Eakins, P. R. THE GEOLOGIST'S ROLE IN MODERN EXPLORATION: Can. Mining & Metall., Bull. v. 53, no. 583, p. 873-876, Nov. 1960, 4 refs.

A brief historical review of the techniques of mineral exploration prefaces a plea for more geological work for the geologist engaged in the search for mineral deposits. The importance of geological information and interpretation in exploration is stressed.--Auth.

3-4232. Zakharov, E. E. SOME LAWS GOVERNING THE REGIONAL OCCURRENCE OF FERROUS AND NONFERROUS METAL ORES. Translated by Paul T. Broneer: Internat. Geology Rev., v. 3, no. 8, p. 664-693, 6 maps, Aug. 1961, 15 refs.

This article surveys the geographical distribution of metal ores, grouped into 6 categories: Fe, Mn, Cr, Ag-Pb-Zn, Cu, and Sn. The author reviews the occurrence of these ores throughout the world and their association primarily with broad geotectonic zones. The essential information is encompassed in 6 maps. Legends explain the classification of the deposits by age (metallogenic eras), type, and paragenetic associations of minerals. The symbols for these various classifications of ores are superimposed on maps showing the zones of Precambrian (cratonal), Paleozoic, Mesozoic, and Cenozoic folding. The particular interest of this paper is that the author has made this survey as a preliminary to dividing the earth's surface into metallogenic provinces (of which he distinguishes 21), giving a brief discussion of each and showing its connection to areas of different ages and geotectonic structures. The ultimate aim is to construct "prognostic maps," or maps drawn on such a basis that they may be used to predict the occurrence of a given ore or ores in a given region.--P. T. Broneer.

3-4233. Annotated Bibliography of Economic Geology. 25-VOLUME GENERAL INDEX. VOLUMES 1-25, 1928-1954: 2 v.: Pt. 1, A-L; Pt. 2, M-Z, [Lancaster, Pennsylvania], Economic Geology Publishing Company, 1961.

3-4234. Reece, Alan, and A. L. Mather. GEOCHEMICAL PROSPECTING FOR BASE METALS IN SCHUCHERT DAL, NORTHEAST GREENLAND (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1157-1166, 2 figs., Toronto, University of Toronto Press, 1961) 3 refs.

The bringing into production of a Pb-Zn mine at Mesters Vig, NE. Greenland, in 1955 stimulated the search for minerals in that area by Nordisk Mineselskab A/S, Copenhagen. The general exploratory techniques used in 1956-1957 are described. Simple geochemical techniques successfully revealed the presence of minor galena veins below the permafrost level and covered by 2 m. of glacial drift.--Auth.

3-4235. Fleming, H. W. THE MURRAY DEPOSIT, RESTIGOUCHE COUNTY, N. B. - A GEOCHEMICAL-GEOPHYSICAL DISCOVERY: Can. Mining & Metall. Bull. v. 54, no. 587, p. 230-235, 9 figs., March 1961, 7 refs.

In 1955, the results of a regional, geological interpretation of the northern portion of New Brunswick were used as a basis for selecting for intensive exploration, 3 areas in which structural and stratigraphic conditions were believed to be favorable. Airborne electromagnetic work in one of these areas provided the justification for acquiring the Murray group. Even though the initial results were discouraging, this geological interpretation, combined with the fortuitous discovery of Cu-bearing float, was sufficient reason for carrying out further work using geochemical methods.

This work finally resulted in the discovery of the Murray massive-sulfide deposit, after about 18 months of coordinated exploration on the property. While this deposit is a typical New Brunswick-type base-metal occurrence, extensive leaching has produced a fossil gossan that rendered it an elusive target for exploration techniques of limited penetration.

Full credit for localizing the target area is given to the geochemical techniques, but geophysical surveys were needed to provide the necessary information as to the nature of the occurrence, and to indicate the most favorable drilling sites.

The electromagnetic and magnetic data were interpreted to be indicative of a good nonmagnetic conductor. On this basis, it was correctly predicted that massive pyrite would be encountered in drilling. As in other New Brunswick deposits, variable quantities of galena, sphalerite and chalcopyrite are associated with the massive-sulfide mineralization. A test of self-potential survey also produced a significant anomalous pattern.

The geochemical data which led to the discovery of this deposit are presented in this paper, along with the geophysical data obtained by various methods in order to compare their effectiveness.--Auth.

3-4236. Corbett, J. O. EMPIRICAL DEMONSTRATION OF GEOPHYSICAL METHODS ACROSS THE CARIBOU DEPOSIT, BATHURST, N. B.: Can. Mining & Metall. Bull., v. 54, no. 587, p. 227-229, 3 figs., March 1961, ref.

A brief discussion of 6 geophysical exploration techniques - vertical loop EM, horizontal loop EM, self-potential, vertical loop EM "broadside" method, resistivity, and audio frequency magnetometer (AFMAG) - carried out over the Caribou massive sulfide deposit.--P. R. Eakins.

3-4237. Radkevich, E. A. ON THE TYPES OF METALLOGENIC PROVINCES AND ORE DISTRICTS. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 9, p. 759-783, Sept. 1961, 60 refs.

This paper discusses various aspects of the metallogenic classification of ore provinces and districts. The nature of the ores is related not only to the time of formation or the stage of geologic development with which they are associated, but also the geologic structure and the mineral composition of the rocks containing them.

In both ancient and young regions 2 types of development have been established: femic in zones of deep faults, and sialic in areas of subsidence. In all types of ore regions there are 3 principal categories of structure which determine the positions of the ore zones - basins, uplifts, and marginal faults. The metallogenic significance of these structural elements is different in regions of different natures.

The former metallogenic conception of the relationship between the nature of the mineralization and the time of its formation and its association with a given stage of geotectonic development must be supplemented by the new concept of the structural position of the ore-bearing zones: not only the time of the igneous activity, but also the structural disposition of the ore zones and their geologic history, determine their metallogenic features. Mineralizations of different types may develop at the same time in adjoining zones.--Royer and Roger, Inc.

3-4238. Radkevich, B. A., and I. M. Tomson. MICA FLUORITE TOPAZ MINERALIZATION SUPERIMPOSED ON SULFIDE MINERALIZATION IN THE SHCHERBAKOV ORE FIELD: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 92-98, 8 figs., table, pub. 1961.

The Shcherbakov ore field is associated with northwesterly trending faults which outline a regional zone of weakness which itself trends NW. along the Pkhusan valley, from the Sea of Japan to the Sikhote-Alin crest. This ore center in the S. Maritime province is associated with a brachyanticlinal uplift in Upper Cretaceous extrusives overlying upper Paleozoic(?), Triassic(?), and Lower Cretaceous sedimentary rocks.

The Shcherbakov ore field, represented by Sn-polymetal cassiterite-sulfide veins, has been affected by a high-temperature greisenlike mica-fluorite-topaz mineralization, with cassiterite, which is younger than the veins and which is superimposed on the polymetal mineralization. The mica-fluorite-topaz association is missing in almost all other cassiterite-sulfide deposits in the maritime province related to the Shcherbakov ore field. Present in the ore field are 4 paragenetic associations corresponding to different stages of intermediate to low temperature mineralization.

The mica-fluorite-topaz association was formed after an intensive shattering of one of the above paragenetic associations, and its formation was again followed by a new sulfide stage. The paragenetic association of mica-fluorite-topaz veins is similar to that of high-temperature greisens but the conditions of formation of these veins are quite different from those of greisens. Structural features of the various minerals and the extensive development of reactions between minerals suggest a radically changing physical and chemical environment accompanied by a higher temperature compared with the preceding sulfide stage. These micaceous forma-

tions came about by an additional injection of magma after the formation of the main body of comparatively low-temperature cassiterite-sulfide ore veins. The presence of diversified but essentially contemporaneous cassiterite-sulfide and mica-fluorite-topaz mineralizations may be related to magmatic sources lying at different depths.--J. W. Skehan.

3-4239. Zoppis Bracci, Luigi. VIEJAS MINAS DE PLATA EN MACUELIZO [Old Silver Mines in Macuelizo]: Nicaragua, Servicio Geol. Nac., Bol. no. 4, p. 39-59, 8 illus., 2 maps, 1960, 3 refs.; text in Spanish.

Ag and some Au have been mined near Macuelizo, Nueva Segovia Dept. since the Spanish colonial days. The Au and Ag occur in quartzose veins and dikes of hydrothermal origin, related to the intrusion of a biotite granite intruded into the country rock. The country rock consists of micaceous-quartzose schists overlain by the Totagalpa formation (red beds) of probable late Paleozoic (but possibly Mesozoic or Tertiary) age. The Totogalpa in turn is overlain by Tertiary volcanics and alluvium. Twelve mines date to the Spanish colonial days, and 2 are younger. Other mineralized zones are present. Assays of the better samples from the different mines, pits, and mineralized zones show a range in Ag content from 4 to 750 g. per ton, and a range in Au content from traces to 1 g. per ton. Some of the prospects have economic potential, and drilling should be conducted to determine the extent of the deposits. S in possibly commercial quantity is present in 2 prospects and could be used for the production of sulfuric acid.--A. A. Meyerhoff.

3-4240. Riley, Christopher. THE RIVER JORDAN LEAD ZINC DEPOSIT, REVELSTOKE MINING DIVISION, B.C.: Can. Mining & Metall. Bull., v. 54, no. 590, p. 437-441, 7 figs., 2 tables, June 1961.

A relatively unexplored Pb-Zn deposit lies about 2 mi. NW. of Revelstoke, British Columbia, in the highly metamorphosed Monashee group of rocks of the Shusway terrane (Pre-cambrian). Host rocks are of dedimentary origin and consist of gneisses, schists, marbles, and quartzites with intermediary types. The marbles and quartzites provide good horizon markers.

Using these it is possible to interpret the controlling structure which is a syncline overturned to the N. dipping S. at about 45°, and plunging E. at about 12°. The syncline is truncated at about halfway of its length on a peak on the W. side of which a partial cross section together with superimposed minor folds may be seen. The quartzites and the 2 marble beds may be traced over much of the structure.

There are 2 lodes, above the marble and below the quartzite, which converge eastward and which are the exposed edges of the same host bed - an impure limestone. The S. or No. 1 lode is the thicker and is considered to be the chief potential ore source. This lode is exposed at intervals for 7,200 ft. from an elevation of 5,800 to 7,900 ft. and has an average thickness of 5 ft.

Sampling, together with the cross sectional exposures at the W. end, permitted grade and rough tonnage estimates to be made of No. 1 lode, not counting the potential tonnages of the superimposed folds. This was 2,873,000 tons having a grade of 1.1 oz. of Ag., 5.1% Pb. and 5.6% Zn.

There is evidence of zoning, particularly of the Pb., Zn. and local barite gangue with suggestions of a Zn. envelope at the extremities of the lode. The syncline appears to have been truncated by erosion at about halfway of its length to the W. This, with the strength of mineralization at this place, suggests that it could have formed a lode originally 14,000 ft. long, and if it maintained its original width of 5 ft., which it could well have done, it would have been an almost unique deposit. Erosion appears to have removed over 3 million tons from the present No. 1 lode so that the original tonnage could have been 12,000,000 tons. Other deposits of great length in relation to their widths are known in the Shuswap terrane in both the Revelstoke and Kamloops mining divisions.

The ease of preliminary evaluation is compensated for in difficulties presented to secondary stages of development due to paucity of good drill locations and length of cross cut tunnel to the lode. However, some drilling can be done in the central part, and second steps should be taken at an early date so that production should not be unnecessarily delayed in case of an increase in Pb. and Zn. prices.--Auth.

3-4241. Fraser, D.C. CUPRIFEROUS PEAT: EMBRYONIC COPPER ORE?: Mining & Metall. Bull. v. 54, no. 591, p. 500-503, table, July 1961, 7 refs.

Cu occurs invisibly in a geological environment characterized by swampy conditions and an accumulation of forest peat. The Tantramar Marshes about 7 mi. N. of Sackville, in southeastern New Brunswick, contain up to 10% Cu (dry weight), in the organic sediments. This occurrence appears unique in that the metal is apparently organically combined in a chelate compound. Unlike the acidic nature of most peat bogs, the pH of the cupriferous peat is nearly neutral.

Analyses of the peat and associated soils have indicated that the bulk of the Cu is contained in the organic sediments. It appears that the Cu distribution is affected by capillarity, evaporation and the growth of frost crystals, and that the Cu fixation is effected by organic sequestration resulting in the metal being bound to the N or O components of the forest peat. While such a fixation mechanism is not definitely established as responsible for the immobilization of the metal, the facts at hand are compatible with this preferred hypothesis, which not only accounts for the invisibility of the Cu substance, but also explains its relative restriction to the organic sediments.

The conclusions reached regarding the nature of this swamp environment appear to offer a possible explanation for the genesis of certain indurated bedded Cu deposits. It is suggested that the chelation mechanism of Cu concentration may have been a factor in the localization of other deposits in the geologic past.--Auth.

3-4242. Dale, Vernon B., and others. TUNGSTEN DEPOSITS OF COCHISE, PIMA, AND SANTA CRUZ COUNTIES, ARIZ.: U.S. Bur. Mines, Rept. Inv. 5650, 132 p., 48 figs., 1960, refs.

Wolframite first was identified in Arizona in 1896 by W.P. Blake, Territorial Geologist. W mining began about 1900 in the Little Dragoon deposits of Cochise County, and about 1901 in Las Guijas district of Pima County.

The price history of W is an erratic one; consequently, production has been erratic. Prices rise during wars and periods of national preparedness. Production of W ore was stimulated greatly by a government purchasing program, announced on May 10,

1951, wherein the government agreed to purchase standard-grade W concentrates at $63 per short ton unit for 5 years or until 1,468,750 units were purchased. This was later increased to 3,000,000 units, and after this amount had been purchased in June 1956, the purchase of an additional 1,500,000 units was authorized. Government purchase, however, was suspended in Dec. 1956 before completion of this latter program, and the price of W concentrates declined sharply. The price had dropped to $15 per short ton unit, duty extra, by the last part of July 1957.

The word "ore" as used in this manuscript does not differentiate between submarginal W-bearing material and ore that could be mined at a profit. The price history shows why it is difficult to classify W-mineral-bearing materials. A table shows average prices, from 1900 to 1956, of concentrates containing 60% WO_3 per short-ton unit.

Mining activities were being carried on at only 4 of the properties visited during the course of this investigation. The majority of the properties contained small, sporadically mineralized, discontinuous ore deposits. However, in 2 localities, the Chiricahua-Dos Cabezas area of Cochise County, and the Baboquivari area of Pima County, further prospecting and testing might disclose low-grade deposits of sufficient extent to warrant small, open-pit operations during periods of high W price. Virtually all of the deposits are in mountainous country, and since most of them are small, transportation and mining costs are proportionately high.

An effort has been made to determine the position of the various deposits by section, township, and range, and to give accurate road directions to each property from a prominent landmark. All available maps have been used to make these determinations, but in unsurveyed areas it has been necessary to make approximate projections of subdivisions. The township and range numbers refer to the Gila and Salt River base and meridian.

Numerous rock samples were taken in the field for laboratory identification. Detailed petrographic descriptions are included in the appendix. The appendix also contains a log of all assays made during the course of the investigation.--From auth. summ. & introd.

3-4243. Laganá, Tito. EL TUNGSTENO Y EL MOLIBDENO DE MACUELIZO [Tungsten and Molybdenum of Macuelizo]: Nicaragua, Servicio Geol. Nac., Bol. no. 4, p. 13-16, 2 maps, 1960; text in Spanish.

Two years ago, a highly mineralized zone with W and Mo was found; this is a preliminary report of findings to date. The deposit is located in Nueva Segovia Dept., on the Honduras frontier, 199 km. from Managua by road. The W and subordinate Mo occur in 2 to 20-in. wide, parallel, hydrothermal, quartzose veins associated with a granite-granodiorite batholith. This batholith intrudes a schistose metamorphic complex of possible Mesozoic or Paleozoic age. The lengths of the veins range from 150 to 2,000 ft. Some contain molybdenite alone, others contain only wolframite, and others contain wolframite and scheelite. Wolframite and scheelite are also found sometimes in the siliceous alluvial deposits of recent streams. One analysis of a vein specimen gave the following results: 71.66% WO_3; 0.07% Mo; 0.044% Cu; less than 0.01% Sn; less than 0.05% Pb; and 0.005% As. If this analysis is representative, the prospect may be highly commercial, depending upon its size.--A. A. Meyerhoff.

3-4244. Goodwin, A. M. GENETIC ASPECTS OF MICHIPICOTEN IRON FORMATIONS: Can. Mining & Metall. Bull. v. 54, no. 585, p. 38-42, 5 figs., Jan. 1961, 12 refs.

The Michipicoten area, Ontario, one of numerous Fe-bearing "Archean" segments in the Canadian Shield, contains 2 main types of Fe formation, a normal Keewatin type, consisting of interbanded chert, siliceous magnetite, and jasper, and, gradational to this, a carbonate-sulfide type which contains large deposits of siderite and pyrite. The carbonate-sulfide type of Fe formation bears a direct relationship to the volcanic development of the area; it thereby affords some insight into genetic problems of Archean Fe formation in general. The purpose of this paper is to summarize the geological setting of Michipicoten Fe formations and to briefly review genetic aspects of recent work in the area.

The area is underlain largely by assorted volcanics and sediments of the Michipicoten series and younger, regional granite masses. The rocks have been extensively folded and faulted. Wall rock alteration, trace element composition, and isotope ratios are briefly described, followed by a review of the literature on the origin of the Fe formation.

Evidence pertaining to origin of the Fe formation is considered to favor chemical sedimentation of banded chert, pyrite, and carbonate members in a submarine volcanic environment as a result of large scale hot spring and fumarolic activity. Details of origin undoubtedly varied from place to place, and many problems of emplacement remain unsolved. The main genetic aspects are summarized.--A. C. Sangree.

3-4245. Stubbins, John B., and others. ORIGIN OF THE SOFT IRON ORES OF THE KNOB LAKE RANGE: Can. Mining & Metall. Bull., v. 54, no. 585, p. 43-58, 9 figs., 6 tables, Jan. 1961, 15 refs.

The Fe deposits occur within a relatively small area at the Quebec-Labrador boundary. About two-thirds of the deposits are in Quebec. In the area a thick sequence of Proterozoic sediments with minor volcanic members occupy a regional depression in an ancient basement complex. They are part of a geosynclinal sequence, generally known as the Labrador Trough, which extends N.-S. over a distance of 700 mi. through the heart of the Labrador peninsula and has an average width of about 30 mi.

The rocks in the Knob Lake range are all of sedimentary origin, except for a few diabase dikes. They vary in composition from chemical precipitates to coarse-grained clastics. They are only very slightly metamorphosed and show well preserved sedimentary textures and structures. The most significant stratigraphic unit is the Sokoman Fe formation, which contains the bulk of the direct shipping ores. In the Knob Lake range, this formation shows remarkable continuity and areal extent and maintains a thickness between 400 and 800 ft. It shows persistent and distinct stratigraphic horizons.

The rocks of the area are intricately folded and highly faulted, forming a foothill regional structure. They strike in a NW.-SE. direction and generally maintain an intermediate easterly dip.

The known Fe deposits total 43 separate ore bodies, each containing between 1 and 45 million tons of direct shipping ore that can be mined by open-pit methods. Most ore bodies occur in structural troughs, formed either by distorted and broken canoe-shaped synclines or by the intersection of

homoclinally folded strata and a major strike fault.

The ores are well layered, soft, friable, and porous. They are composed chiefly of various iron oxides. The bedding, compositional layering, and some textures of the Fe formation are well preserved. Physical properties, chemical composition and mineralogy of the ores are discussed, then the bedded ores and associated rocks, and the rubble ores, and their origin.

There is general agreement that the Sokoman Fe formation is a sediment formed mainly by chemical deposition in the late Precambrian. The exact form in which the Fe was originally deposited is unknown, but it is generally agreed that the Fe formation possesses approximately the same chemical composition and physical appearance as the original consolidated sediment.

The bedded ores are believed to have been formed in situ by circulating meteoric waters, percolating downward along bedding planes and fractures and producing leaching and enrichment.

Although the 3 main types of rubble ores clearly originated through different agencies, they all appear to be closely associated. Gravel ore grades into talus ore and the latter grades into breccia ore. All types contain some C or some fossil wood fragments. It is therefore believed that most rubble ores are, in a broad sense, contemporaneous. All sand and gravel ores found to date are within or only a few hundred feet away from major deposits of bedded ores. They appear to be the erosion products of the limbs of the ore-bearing synclines. Judging from the nature of the fragments they contain and the shape of the basins in which they occur, these ores were partly and preferentially eroded. The complex association bebetween the various types of rubble ores suggests recurring movements along the main fault planes, probably extending over a long period. The basins of rubble ore accumulation may have been very shallow at any time, but as the down-warping continued they were gradually filled up by ore talus, gravels and sands.--A. C. Sangree.

3-4246. Farnham, Lloyd L., and others. MANGANESE DEPOSITS OF EASTERN ARIZONA: U. S. Bur. Mines, Inf. Circ. 7990, 178 p., 24 figs., table, 1961, refs.

This paper, one of a series covering mineral resources of the nation includes the counties of Navajo, Apache, Gila, Graham, Greenlee, Pinal, Pima, Santa Cruz, and Cochise. With few exceptions, these descriptions are the result of field examinations by the writers. Work was begun in May 1956, and in the following 18 months 151 deposits were examined. The distribution of the deposits by counties is as follows: 1 in Navajo, and 1 in Apache, 37 in Gila, 4 in Graham, 13 in Greenlee, 25 in Pinal, 13 in Pima, 12 in Santa Cruz, and 45 in Cochise.

In surveyed areas the locations of the deposits are described by section, township, and range, and in unsurveyed areas, by approximate projections of these subdivisions. The township and range numbers refer to the Gila and Salt River base and meridian. The history, production, ownership, geologic setting, and mining methods used are discussed for most of the deposits that were visited. Probably some occurrences have been overlooked, but all of the principal ones have been examined.

Ore dressing studies were made of typical ores from several of the larger districts. The work was performed in the laboratory of the U. S. Bureau of Mines Tucson Metallurgy Research Laboratory. The results of these studies are given with the descriptions of the deposits from which the samples were taken.--From auth.

3-4247. Crittenden, Max D., Jr., and others. MANGANESE DEPOSITS IN THE DRUM MOUNTAINS, JUAB AND MILLARD COUNTIES, UTAH: U. S. Geol. Survey, Bull. 1082-H, p. 493-544, 4 figs., 7 pls. (5 in pocket incl. 4 geol. maps), 4 tables, 1961, 16 refs.

The Drum Mountains are in W.-central Utah 30 mi. NW. of Delta, between the Sevier Desert on the E. and Whirlwind Valley on the W. It is a typically barren desert range comprising a westward-tilted structural unit in which is exposed as much as 9,000 ft. of quartzite (Cambrian and Precambrian?) and 3,000 ft. of carbonate rocks of Cambrian age. These beds which strike northward and dip W., are cut by myriad E.- to NE.-trending faults with displacements of a few feet to a few thousand feet. Quartz monzonite dikes, pebble dikes, and vein deposits are present locally along the faults. The Cambrian rocks are overlain unconformably by volcanic rocks of probable Tertiary age.

Bodies of manganese carbonate ore were formed by replacement of two 20-ft. beds of impure dolomite at the base of the sequence of carbonate rocks, along their intersection with certain preore faults. The feeding fissures locally contain veins in which rhodochrosite is associated with base metal sulfides. Downward-moving meteoric water has oxidized the ore bodies to a depth of 100 to 200 ft. except where they are sealed off by structural or stratigraphic traps.

From 1925 to 1953, 72,462 long tons of Mn ore with an average grade of about 25% Mn were shipped. --Auth.

3-4248. Sanderson, L. CORUNDUM AND EMERY: Can. Mining Jour., v. 82, no. 8, p. 73-75, Aug. 1961.

Information is summarized regarding physical properties and geologic occurrences of corundum and emery with notes on mining and milling methods, marketing, grading, and uses. Geology and mining practice are briefly mentioned for corundum deposits in the U. S. A., Canada, and Greece.--W. C. Peters.

3-4249. Rowe, Robert B. WANTED - A BETTER SOURCE FOR BERYLLIUM: Can. Mining Jour., v. 82, no. 8, p. 55-57, Aug. 1961, 12 refs.

Exploration for Be deposits has been stimulated by discoveries of nonpegmatite replacement deposits of bertrandite and phenakite. Possibilities for large-tonnage production are readily recognized. Limited metallurgical experience with bertrandite and phenakite is a critical factor in evaluating individual deposits.

Six replacement deposits of particular interest are mentioned, with geologic notes: The Boomer Mine in Colorado; the Mount Wheeler prospect in Nevada; the Spors Mountain area in Utah; the Agulachile deposit in Coahuila, Mexico; the Seal Lake, Labrador, barylite deposit; and a new discovery of beryl-bearing schist in Brazil.

Suggestions are given for Be prospecting in the crystalline areas of Canada, with particular concentration on areas of granitic and alkaline rocks, contact metasomatic deposits, and greisens. Conventional exploration methods are recommended; the berylometer, while recognized as an invaluable tool, is not considered suitable for general prospecting

because of cost, licensing, and transportation problems. Identification of mineral associations rather than of Be minerals themselves is suggested as a prospecting technique.--W.C. Peters

3-4250. Van Sant, Joel N. REFRACTORY-CLAY DEPOSITS OF WYOMING: U.S. Bur. Mines, Rept. Inv. 5652, 105 p., 31 figs., 3 tables, 1961, refs.

The rapidly expanding economy of the West, with its growth of heavy industry and increased steel production, is primarily responsible for the refractory clay industry's concern over the adequacy of the clay supply in states of the Great Plains and Rocky Mountains. The Wyoming investigation is a part of the national program devised to close gaps in the domestic supply of specific types of clays to determine their characteristics and properties and to provide information that will assist the refractory-clay industry.

Forty-two locations of clay-bearing rock in 17 areas in Wyoming were examined. The Hulett, Aladdin, and Newcastle areas are discussed in the section on the Black Hills district; the other 14 areas are described separately.

Forty-two clay samples were collected, and tests showed that 14 of the samples were refractory to a certain degree. Five clays were sub-low-duty grade, 8 were low-duty refractory, and 1 was high-duty grade. The refractory clay beds occur in rock formations ranging from Jurassic Morrison to Eocene Wasatch. Data obtained during this investigation indicated that the Morrison, Cloverly, Frontier, and Evanston formations were more favorable for refractory clay in Wyoming.

In 1957 there were no refractory-clay mines or refractory-clay products plants in Wyoming. A few thousand sub-low-duty fire-clay bricks were made annually at Sheridan, Wyoming, in manufacturing heavy-clay products.

Wyoming chiefly has a stock-raising and agricultural economy in which a few thousand 9-in. equivalent refractory-clay products are used. Most refractory-clay products are used annually by oil refineries, the mining industry, and the railroads. Small demand makes it improbable for a refractory clay products plant to operate profitably in Wyoming. The only market for Wyoming fire clay is outside the state. Wyoming fire clay found thus far within economic shipping distance of the refractory clay products plants in Colorado is inferior to Colorado fire clay.

The only Wyoming clay of high-duty quality found during this investigation occurs near the Wyoming-Utah border. The deposit is within economic shipping distance of the Utah clay-products plants. Utah has clay suitable for making refractory products. However, the deposits have costly firing characteristics or are so far from rail transportation and manufacturing plants that, in 1957, Colorado fire clay could be shipped at lower cost more than 500 mi. to the Utah market. Therefore, the Wyoming clay might compete favorably with Colorado clay now used because of the advantage of low-cost transportation.

Prospecting near Evanston, Wyoming, might disclose significant deposits of this high-duty refractory clay which could be mined and sold in the Utah market. Low-grade refractory clays occurring in other parts of Wyoming are so far from existing markets that they were not considered of commercial value in 1957.--From auth. summ.

3-4251. Zoppis Bracci, Luigi, ed. RECONOCIMIENTO GEOLOGICO-MINERO PARA EL FOSFATO EN EL DEPARTMENTO DE RIVAS [Geological and Mineral Reconnaissance for Phosphate in Rivas Department]: Nicaragua, Servicio Geol. Nac., Bol. no. 4, p. 85-117, map (in pocket), sec. (in pocket), table, 1960, 4 refs.; text in Spanish.

The area investigated lies between Lake Nicaragua on the E. and the Pacific Ocean on the W. The oldest recognized stratigraphic unit is the Upper Cretaceous Rivas formation, with a minimum thickness of 2,370 m. Along Lake Nicaragua, the exposed Rivas consists, from base to top, of metaarkose with shaly intercalations, succeeded by shales, sandstones, graywackes, and tuffs. The formation appears to thicken westward (4,100 m. plus). Volcanic constituents increase to the S., suggesting the presence of volcanos on Santa Elena peninsula, Costa Rica. The entire sequence was deposited in shallow water and is marine. Concordantly above is the marine Eocene Brito formation, composed of some 2,400 m. of calcareous sandstone, shale, breccia, tuffs, and near the top, upper Eocene-lower Oligocene orbitoid limestone. Lying above with marked angular unconformity is the marine Pliocene "Madreporica" limestone. Recent alluvium and volcanic ash complete the sequence. Pre-Pliocene structure is characterized by NW.-SE. strikes, mostly in the form of a SW.-dipping regional monocline. Dips range from 20° to 75°. The Rivas anticline, at least 24 km. in length and asymmetric to the NE., occupies the northeastern part of the area Many small normal faults occur, as well as a few tear faults perpendicular to regional strike. One of these has an apparent horizontal offset of 3 km. Most of the phosphatic horizons found occur in the Brito formation, but in no case does the percentage of P_2O_5 exceed 0.09%. A total of 161 analyses was made from the Rivas and Brito formations. None of the beds is commercial in quality and there is little prospect of encountering commercial phosphate deposits in this area.--A.A. Meyerhoff.

3-4252. New Mexico, Institute of Mining and Technology. BIENNIAL REPORT FOR THE FISCAL YEARS ENDING 30 JUNE 1959 AND 30 JUNE 1960: 37 p., illus. (3 col.), graph, Socorro, 1960.

This biennium witnessed the end of a remarkable decade of mineral production in New Mexico. During the 1950's the state's mineral production increased from an annual rate of around 200 million dollars in 1950 to well over 600 million in 1960. The value of mineral production during these 10 years, amounting in total to 4.2 billion dollars, is about twice the total value of mineral production in all the years prior to this period.

Probably the most important single development during the decade of the fifties was the rise of the U industry from a position of nonexistence to one that ranked next to petroleum in terms of the value of the product produced. In the calendar year 1959 the value of the U concentrates produced in New Mexico well exceeded 100 million dollars.

Of importance to the mineral economy of the state during the last 2 years has been the establishment of the first cement industry and the first gypsum industry.

The mineral industry as a whole continued, by a wide margin, to be the chief single source of tax revenue for the state.

The activities of the New Mexico Bureau of Mines and Mineral Resources comprised basic and practical studies in the various phases of the minerals industry, including for the first time some rather extensive studies on the beneficiation of low-grade and re-

fractory ores. Details of the Bureau's activities are summarized in this biennial report.--Foreword.

3-4253. Solórzano Marín, Roberto. ANALISIS Y PERSPECTIVAS INDUSTRIALES DE LOS RECURSOS MINERALES DE NICARAGUA [Analysis and Industrial Potentials of the Mineral Resources of Nicaragua]: Nicaragua, Servicio Geol. Nac., Bol. no. 4, p. 119-161, 1960, 10 refs.; text in Spanish.

Metallic minerals found in Nicaragua, with a good economic potential, include Sb, Cu, Fe, pyrite, Au, Ag, Mo, W, and Pb. Nonmetallic deposits of potential economic value include pozzolanic materials, diatomaceous earth, gypsum, marble, other ornamental stone, pumice, limestone, clays, jasper, chert, and salt. All have potential economic use both within and outside of Nicaragua. Some, such as pyrite, gypsum, and Fe, are known from only 1 or 2 localities to date. Others, such as Au and Ag, have been mined over a long period of time, but large deposits are unknown. The principal problems are, 1) that neither sufficient field mapping nor core drilling has been carried out to determine the extent and commercial value of known deposits; and 2) that much of the country outside of the known deposits is relatively unexplored for mineral potential.--A. A. Meyerhoff.

13. FUELS

See also: Geologic Maps 3-3949; Stratigraphy 3-4031; Geophysics 3-4104; Geochemistry 3-4141, 3-4142; Mineral Deposits 3-4233, 3-4252; Engineering Geology 3-4285.

3-4254. Woods, J. P. YEARS AHEAD FOR EXPLORATION: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 7, p.1014-1017, 12 figs., July 1961.

Exploration plans have been dropped, curtailed, or deferred. This is a simple, direct way to cut expenditures and improve the immediate profit picture. Seismic work in the U.S. has been falling whereas foreign seismic work has increased at an astonishing rate.

The oil industry fears, not a glut of oil, but rather a lack of adequate reserves. Despite intensive exploration, reserves have not increased fast enough. The discovery need is even now much greater than the actual discovery rate. Great demands will be made of exploration in the years just ahead - demands that will come at a time when valuable men have left exploration, and at a time when colleges have few graduates in geology and geophysics.--F. E. Kottlowski.

3-4255. Zink, Edman R. GEOLOGIC HIATUS: Oil & Gas Jour., v. 59, no. 30, p. 116-117, 2 figs., July 24, 1961.

The exploration geologist, in many cases, is overlooking tools such as drill cuttings and cores which are just as important as electric logs or seismograph records. Suggestions are made in this short paper on how to make the most use of all information and stop geologists from contributing to a modern-day "geologic-hiatus."--T. C. McLean.

3-4256. HOW SAND GRAINS TELL WHERE TO DRILL NEXT: Oil & Gas Jour., v. 59, no. 30, p. 40-41, 3 illus., July 24, 1961.

Shell Oil Company has come up with a method of predicting the direction in which a sand deposit lies along an ancient river bed or seashore. Known as the Nanz method, it makes use of the relationship between the direction in which sand grains are elongated and the trend of the entire sand body. This becomes an important oil field development tool when planning development well locations.--T. C. McLean.

3-4257. McGhee, Ed. PROJECT MOHOLE: FULL OF PROMISE FOR OFFSHORE OIL HUNTERS AND DEEP DRILLERS: Oil & Gas Jour., v. 59, no. 28, p. 108-113, 4 illus., map, July 10, 1961.

After the success of practice runs offshore from California and Mexico, there seems to be little doubt that the Mohole will be drilled. The Mohole will inadvertently aid the oil industry as it will be a record-depth hole drilled in the ocean. It is expected to improve the industry's ability to 1) drill extra-deep wells and 2) to drill offshore areas. The practice holes have already revealed that the "outboard-motor" method is effective for holding a floating drill ship in position and that long, unspotted strings of drill pipe can be rotated and drill routinely in very deep water.

When the Mohole itself is drilled, there is a good chance of gaining the following information: 1) development and testing of drill pipe and casing for holes 30,000 ft. and deeper; 2) improvement in equipment and methods for completing and producing wells on the ocean floor; and 3) better standards for design of floating drill ships. The oil industry also hopes to profit through 1) new ideas to speed round trips with the drill pipe; 2) new drilling methods to drill farther and faster without pulling the drill pipe; and 3) better geological and geophysical techniques for locating oil.

The article describes some problems to be anticipated and solutions discovered in drilling the practice holes.--L. M. Dane.

3-4258. Stegena, L. ON THE PRINCIPLES OF GEOCHEMICAL OIL PROSPECTING: Geophysics, v. 26, no. 4, p. 447-451, 5 figs., Aug. 1961, 15 refs.

The geochemical prospecting method is based upon the circumstance that the gases of the oil reservoirs migrate vertically as demonstrated by sensitive analytical techniques. Some unsatisfactory results and the criticism raised concerning the method have made necessary the investigation of the fundamental principles of the process. Gas migration is caused partly by differences in concentration, partly by differences in pressure. The migration caused by the former factor is termed diffusion, that caused by the latter one is called effusion. This paper attempts the quantititive treatment of diffusion.

The results of this treatment are as follows: 1) In case the reservoir is situated at a great depth and in case the superincumbent layers are highly impermeable, a time interval is necessary to reach steady-state diffusion which is significantly above the lifetime of the reservoirs; 2) In other cases, where the depth is not too great, or the superincumbent layers are fairly permeable, a steady-state diffusion has to be reckoned with.--Auth.

3-4259. Gaither, L. Q., and W. G. Egerton. AIRBORNE GEOPHYSICAL SURVEYING: Oil & Gas

Jour., v. 59, no. 24, p. 180-182, 184-185, 7 figs., June 12, 1961, 6 refs.

Here is a method of geophysical surveying where the area to be surveyed is flown in a series of traverses with a conventional 2-engine airplane. Continuous recordings are made of one or more electrical fields produced from separate sources.

The recorded information is analyzed and contoured on area maps with the higher-intensity contours correlative to geological features. Horizontal control is accomplished by aerial mosiacs; aerial photos are shot during the survey and are synchronized with the recorders.

With this method of surveying, 1,600 hours of flying time were required to map 140 areas. Forty-two of these were recommended for exploratory drilling. Thirty of the recommended anomalous areas were drilled, resulting in 20 discoveries of oil or gas condensate.

The mapped data produced significant anomalies which are consistently repeatable and are correlatable with certain types of geological structures. Advantages of airborne surveying are that terrain hazards and other problems frequently associated with ground crews are nonexistent, and the relatively economical cost of about 10 cents per acre for operation makes it very useful for both reconnaissance and detailed surveying.--Auth., p. 180, 185.

3-4260. Geyer, Richard A. GRAVITY-MAGNETICS CAN BE AN EFFECTIVE TOOL FOR OIL FINDERS: Oil & Gas Jour., v. 59, no. 29, p. 126-128, 6 figs., July 17, 1961.

As a tool for petroleum prospecting, the magnetometer performs an indirect rather than a specific means for locating possible petroleum-bearing structures. Either the ground or airborne types of magnetometer can yield information on the aerial extent and configuration of sedimentary basins and the thickness of these basins. A gravity map, whether the data are obtained by a land-type instrument or with an airplane, can greatly accentuate the magnetic survey.--T. C. McLean.

3-4261. Bleakley, W. B. USE THE RIGHT LOG: Oil & Gas Jour., v. 59, no. 24, p. 106-112, 4 figs., 2 tables, June 12, 1961.

In the last 15 years there have been many advances in well logging. The purpose of this article is to show what log should be used under what conditions. Terms such as drilling fluid, drilling mud, casing, and formation type are first defined. Then various logging methods are discussed. The limitations and application for the following logs are presented: electrical logging, induced-current logging, focused electrode logging, microresistivity logging, microfocused resistivity logging, radioactivity logging, velocity logging, density logging, and salinity logging. --L. M. Dane.

3-4262. Guyod, Hubert, and John A. Pranglin. NOW - GET TRUE RESISTIVITIES FROM CONVENTIONAL ELECTRIC LOGS: Oil & Gas Jour., v. 59, no. 24, p. 113-118, 9 figs., June 12, 1961, 3 refs.

True resistivity is the key to accurate electric-log interpretation. Many conventional logs taken in favorable reservoirs have probably been interpreted as noncommercial because a true resistivity of the formation in question could not be found.

This article describes a method developed for determining the true resistivities of beds and, in many instances, the resistivities and extents of their invaded zones, from an electric log composed of a 16-in. normal, a 64-in. normal, and 18-ft. 8-in. lateral. Data needed for preparing the charts were obtained with a resistivity analog computer.--From auth., p. 113.

3-4263. Rodermund, C. G., and others. LOGGING EMPTY HOLES: Oil & Gas Jour., v. 59, no. 24, p. 119-124, 9 figs., table, June 12, 1961, ref.

An empty-hole logging program for the fractional analysis of reservoir fluids lacked a fundamental porosity tool until the advent of the density device. Now, by combining the bulk density of the formation with the hydrogen index, or with the true resistivity, the true porosity and fractional fluid saturations may be computed.

A table summarizes the proper conditions for log selection and the corresponding interpretation methods. The neutron log and induction log are somewhat interchangeable, particularly when gas is the only hydrocarbon present. In general, the induction log is preferable, since the neutron log is bothered by shaliness, and the hydrogen-index calibration is sometimes difficult. On the other hand, the density log is practically unaffected by shaliness, is readily calibrated, and works as well in empty as in mud-filled holes. It has, in fact, shown itself to be the key to all interpretations in empty-hole logging.--Auth. concl.

3-4264. Busch, Daniel A. MAKE THE MOST OF THOSE ELECTRICAL LOGS IF YOU WANT TO FIND STRAT TRAPS: Oil & Gas Jour., v. 59, no. 28, p 162-163, 166-167, 4 figs., July 10, 1961, 2 refs.

Electrical logs are proving to be indispensable in defining stratigraphic trap prospects. In this type reservoir, a detailed knowledge of the paleogeographic environment of deposition is essential. Electrical logs afford the necessary markers for identifying and analyzing genetic sequences which, in turn, are necessary to the reconstruction of the surface of deposition of reservoir sands.

The article discusses some geological applications which can be made by the geologist in 1) establishing detailed subsurface correlations where sample studies alone would be inadequate; 2) analyzing the geological control on a stratigraphic trap and using it as a basis for predicting a new pool; and 3) analyzing the porosity and fluid characteristics of a reservoir sand from electrical logs in reevaluating a "dry hole."--From auth., p. 162, 166.

3-4265. Pierce, Clyde I., and others. OIL-WELL LOGGING WITH MODEL EQUIPMENT: TESTS ON NONINVADED THIN BEDS WITH SHIELDED ELECTRODES: U. S. Bur. Mines, Rept. Inv. 5788, 19 p., 11 figs., 1961, refs.

Describes and presents results of a phase of a laboratory study conducted at the Morgantown Petroleum Research Laboratory, U. S. Bureau of Mines, Morgantown, West Virginia, to determine the response of shielded electrodes of different dimensions in thin, noninvaded beds and to stimulate interest in the use of focused-type logging devices in the Appalachian oil fields.

A blotter model was used to obtain plots of the potential field in the vicinity of a model shielded electrode.

Three plots are presented. The difference in curvature of equipotential lines and the variation in measured resistance values for different blotter-model conditions suggest that the shielded electrode will give resistivities higher than normal when measurements are taken in a thin conductive bed located between resistive beds, and resistivities lower than normal when measurements are taken in a thin resistive bed located between conductive beds.

An electrolytic tank model, 18 in. in diameter and 36 in. deep, was used to determine the response of miniature shielded electrodes in noninvaded beds having object-to-adjacent-bed resistivity ratios of approximately 0.03, 0.08, 12, and 33. Sandstone disks, 16 in. in diameter, ranging from 1 to 6 in. thick were used in setting up model reservoirs. Each disk had a 5/8-in. drill hole along its cylindrical axis. The disks served as resistive beds and water as the conductive beds.

Logs were obtained in the model reservoirs using 6 miniature shielded electrodes 1/2 in. in diameter, having length-to-diameter ratios ranging from 4 to 17, and measuring electrode lengths of 3/32, 1/4, and 1/2 in.

Apparent resistivities given by the shielded electrodes, for a resistive bed between conductive beds, ranged from 68 to 93% of the true bed resistivity for bed-thickness-to-hole-diameter ratios ranging from 1.6 to 9.6. For a conductive bed between resistive beds, values ranged from 163 to 100% of the true values for bed-thickness-to-hole-diameter ratios ranging from 1 to 18.

Logs obtained with devices used in this work exhibit false detail but, from a practical standpoint, this would not be objectionable because the relative magnitudes of the false indications are small. The spread between maximum and minimum log values in a uniformly conductive bed was less than 8%.

Results of this work suggest that little is gained by using devices with a length-to-diameter ratio greater than about 8 in noninvaded resistive beds when hole-to-electrode-diameter ratios are small. They also suggest that the effect of adjacent beds on the response of the guard electrode is small.--Auth. summ.

3-4266. Smith, William O. MECHANISM OF GRAVITY DRAINAGE AND ITS RELATION TO SPECIFIC YIELD OF UNIFORM SANDS: U.S. Geol. Survey, Prof. Paper 402-A, 12 p., 9 figs., 3 tables, 1961, 16 refs.

The capillary theory of retention of water and of drainage under a gravity of 1 is developed for uniform sands. It is shown that the meniscus enclosing the water bodies retained in the sand is broken off from the meniscus of maximum capillary rise as it falls through the sand. Quantitative expressions for the specific yield of a uniform sand also are derived. It is shown that the initial drainage under a maximum capillary rise meniscus accounts for the bulk of the drained water. The data of F.H. King and of Allen Hazen are analyzed; the results were in good agreement with the theory as developed in this report. Comparative calculations are given for crude petroleum. The problem of water drive in an oil-bearing sand is discussed briefly on the assumption that the capillary bodies of oil retained are initially formed by the oil-water interface as it passes through the sand.--Auth.

3-4267. Carman, E.P., and Frances S. Bayes. OCCURRENCE, PROPERTIES, AND USES OF SOME NATURAL BITUMENS: U.S. Bur. Mines, Inf. Circ. 7997, 42 p., fig., 16 tables, 1961, refs.

In this summary, the layman's or dictionary definition of bitumens is used, that is, naturally occurring hydrocarbons. Emphasis is on the less common solid and semisolid bitumens, particularly those occurring or used to some extent in the United States. This comprises data from many sources and references to these sources for more detail than is given in this summary.

This paper was prepared primarily to answer questions about some of the less known bituminous materials. The word hydrocarbons could just as well have been substituted in the title for bitumens. The reader will realize that coals, of which only the more unusual such as the cannel coals and torbanites are discussed in this paper, are primarily mixtures of bituminous materials and C. The amount of bituminous material, or volatile matter, in coals is greatest in the lower rank coals and the unusual types described in this paper, and decreases as coal rank increases. However, since no method other than destruction of the original coal substance by heat is known that will separate the volatile matter from the C, it appears reasonable to classify the coals with other bituminous materials, particularly since bituminous coal - the most widely used coal - by its name indicates the combination of bituminous materials and C.--From auth. introd. & summ.

3-4268. Edie, Ralph W. DEVONIAN LIMESTONE REEF RESERVOIR, SWAN HILLS OIL FIELD, ALBERTA: Can. Mining & Metall. Bull., v. 54, no. 590, p. 447-454, 7 figs., June 1961, 25 refs.

The limestone reef reservoir at Swan Hills consists essentially of a "buildup" of successively smaller atoll-like layers. Precipitation of calcium carbonate within the lagoonal area of each layer essentially kept pace with growth of the outer organic lattice. Within the reef mass, 6 depositional environments characterized by specific suites of fossils (or fossil fragments) and associated limestone textures are recognized as follows:

1) Aerated moderately agitated water of normal marine salinity (widespread shelf or submerged reef-built platform). Thamnopora-type corals, Amphipora, "pancake" stromatoporoids, crinoids, articulate brachiopods, rare rugose cup corals, and ostracods occurs in light gray-buff skeletal microgranular limestone of low permeability.

2) Semi-stagnant quiet water of normal marine salinity (leeward side of reef). Crinoids, articulate brachiopods, rare thamnopora-type corals, Amphipora, pancake and bulbous stromatoporoids, rugose cup corals, ostracods and gastropods occur in impermeable dark brown argillaceous skeletal calcilutite with thin black bituminous shale beds and rare dark chert nodules.

3) Aerated highly agitated water of normal marine salinity (organic lattice). Light buff stromatoporoid bulbs and Amphipora, rare thamnopora-type corals, rugose cup corals, crinoids, and articulate brachiopods from permeable patch reefs and interbedded skeletal calcirudites.

4) Semi-stagnant quiet marine water of slightly increased salinity (partially restricted shelf). Dark gray biostromal "buildups" of stromatoporoid bulbs and minor Amphipora occur in impermeable black shaly matrix.

5) Aerated, quiet to highly agitated marine water of increased salinity (mud flats, tidal channels and shoals within atoll-lagoon). Amphipora, rare ostracods and gastropods occur in light buff impermeable

to highly permeable precipitated limestone (lithographic, microgranular, pseudo-oolitic and intraformational conglomerate).

6) Semi-stagnant quiet marine water of increased salinity (deeper protected pools in atoll-lagoon). Amphipora, rare stromatoporoid bulbs and ostracods occur in impermeable dark brown slightly argillaceous calcilutite of precipitated origin.

Mapping of these environments is of great value in outlining field extensions and evaluation of acreage during development drilling. Use of these techniques, in addition to construction of isopach maps of critical intervals, should also prove to be highly effective in exploration for undiscovered reef oil and gas fields.--Auth.

3-4269. Sproule, J.C. REGIONAL GEOLOGY AND PETROLEUM PROSPECTS: LOWER MACKENZIE BASIN AND ARCTIC COASTAL AREA, NORTHWEST TERRITORIES (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1141-1148, table, Toronto, University of Toronto Press, 1961)

The historical background and present status of geological exploration in the lower Mackenzie basin area are described. Special attention is given in this description to local and regional structure in relation to oil occurrence. Stratigraphy and structural relationships to the better-known portions of the western Canadian basin to the S. and to the Arctic Islands basin areas to the N. are pointed out. The potential oil reserves of this large area are assessed in general terms and reference made to the possible future internal and external market situation.--Auth.

3-4270. Gardner, Frank J. GULF COAST GIRDS FOR NEW ERA IN OIL HUNTING: Oil & Gas Jour., v. 59, no. 34, p. 72-74, map, table, Aug. 31, 1961.

After 60 years of drilling in soft-rock Tertiary formations, oil finders of the Gulf Coastal Plain now face a hard-rock challenge. Reef concept is going to touch off an epic deep-drilling campaign. Hundreds of wildcats will be needed to trace Cretaceous surface along a 700-mi. trend.

The idea of deeply buried Cretaceous reefs was pure theory until a few years ago. Recent exploration, however, indicates at least 3 completely unknown geologic provinces that will require exploration in the future.--T. C. McLean.

3-4271. 65-YEAR SEARCH TAPS FIRST OIL IN KANSAS' OSAGE COUNTY: Oil & Gas Jour., v. 59, no. 31, p. 258, 260, 3 figs., July 31, 1961.

For more than 65 years, wells have been drilled in Osage County in search of oil and gas; in May 1961, Messman-Rienhart Oil Company drilled the "Woodward 1" well as the county's first commercial producer. The well was spudded in the outcropping Pennsylvanian and Permian rocks. Production was found in the Mississippian rocks at a depth of 1,545 to 1,564 ft. The well has been recognized as the official discovery of Vassar field.--T. C. McLean.

3-4272. McCaslin, John C. SAN JUAN DRILLERS TAP PENNSY PAY WITH NEW DISCOVERY: Oil & Gas Jour., v. 59, no. 28, p. 170-171, illus., map, July 10, 1961.

Long-missing Pennsylvanian production has returned to the big San Juan basin of NW. New Mexico - a basin almost totally productive in Cretaceous rocks. Continental Oil Co. completed 3-18 Table Mesa in C SE-NW 3-27n-17w, San Juan County, flowing 21,500 M.c.f.d. plus 15.5 bbl. of condensate per million. Production is from perforations in the lower Barker Creek zone of the Pennsylvanian Paradox at 7,097-7,113 ft. The gas is 5.4% He.--Auth.

3-4273. Petersen, William A. ARE GULF COAST OIL HUNTERS RESTING ON THEIR LAURELS?: Oil & Gas Jour., v. 59, no. 31, p. 254-256, 2 maps, graph, July 31, 1961.

Most upper Texas Gulf Coast oil comes from a few old fields; 24 of them account for some 73% of accumulated production. Of the 24, 20 are of salt-intrusive origin. The production from these fields is discussed in light of the exploration history as related to current work.--T. C. McLean.

3-4274. Sandidge, John R. COMANCHEAN REEF TREND ASTOUNDS GULF COAST OBSERVERS: Oil & Gas Jour., v. 59, no. 30, p. 118-119, 2 maps, July 24, 1961, 7 refs.

The Deep Edwards play of S. Texas has been one of the most spectacular developments the region has seen in many years. With new information to be gained from continued exploration, coupled with an advancing insight as to the interpretation of available data, both geological and geophysical, there is every reason to believe that more important discoveries will be made along this belt.--T. C. McLean.

3-4275. Cram, Ira H. IMPACT OF SOVIET OIL: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 7, p. 1018-1028, 6 figs., table, July 1961.

The U.S.S.R. is a formidable competitor to the oil men of the Free World. Their production of crude oil in 1960 had increased more than 4 times over 1949 production. Sizeable natural gas fields also have been discovered.

The area of sedimentary rocks in the U.S.S.R. is nearly 1.7 times the same kind of area in the U.S.A. The oil and gas fields of the Russian platform W. of the Ural Mountains are of the Permian basin-Midcontinent type. Production is from Devonian sands, lower Carboniferous sands, and Permian reefs. In the southern U.S.S.R. and central Asia, production is from Cretaceous to Pliocene beds in basins similar to the Los Angeles basin. Over 2,000 salt domes are reported in the northern Caspian depression, but production has been minor. Spectacular oil seeps are reported on the flanks of the enormous western Siberian basin.

The wells of the U.S.S.R. have averaged a little over 100 barrels a day. As much as 95% comes from sand reservoirs. They do more geophysical exploration than we and even drill random wildcats in unexplored areas.

Soviet extravagance is striking; there are too many people on the payroll and too much idle equipment. However, their technical people are smart and well trained, and they work. Exploration in the U.S.S.R. has a tremendous financial advantage in that they do not buy leases nor pay rentals.

Most of the exports of U.S.S.R. oil have been for political reasons, often below cost. One of our national pastimes is the underrating of the other fellow. To underrate this particular other fellow is to invite disaster.--F. E. Kottlowski.

3-4276. Stevens, Edmund. THE WORLD'S NO. 2, OIL PRODUCER - THE U.S.S.R.: Fortune, v. 63, no.

6, p. 132-135, 213-214, 216, illus., map, June 1961.

In the past 5 years Soviet oil exports to Western Europe have multiplied almost tenfold, and shipments to all countries outside the Communist bloc are up fivefold - to an estimated 120 million barrels in 1960.

The growing Russian exports mean hard competition for Western oilmen. The Soviet state monopoly of foreign trade permits control of export prices to a degree no free-enterprise nation can match. And Moscow can set favorable terms for barter deals whenever it seems politically advantageous. Behind the export successes there is also a formidable Soviet oil industry. Nikita Khrushchev has boasted that its output will be nearly 3 billion barrels by 1972. (U. S. production last year, albeit below capacity, was 2.5 billion barrels.)

Though Russia was one of the earliest oil producers, the industry slumbered for many years. But it has grown prodigiously since 1946, when a frantic war-born search for new oil fields to replace the dwindling, enemy-threatened Baku wells began to pay off. Already the Soviet industry is producing well over a billion barrels annually, so it seems likely the Khrushchev boast for 1972 may be made good. By then, also, great quantities of Soviet oil will be flowing into the heart of Europe through a new pipeline, now being built.--Auth.

3-4277. Carrier, John B. SPANISH SAHARA OFFERS REAL PROSPECTS FOR OIL: Oil & Gas Jour., v. 59, no. 27, p. 182, 184, 187, 190-191, 5 illus., 2 maps, 2 secs., July 3, 1961, 2 refs.

Spanish Sahara should be of intense interest to the oil industry because of its geologic relationship to other portions of the Sahara region. Some of the world's largest reserves are being developed in Algeria and Libya from structural basins and provinces that are genetically related to similar features in the Spanish Sahara. The Tindouf basin extends into northern Spanish Sahara and the Aaiun basin, of unknown depth, covers the western half of the country. Should the stratigraphic section in these basins prove similar to that of the N.-central Sahara, the oil possibilities for Spanish Sahara will be very real indeed.

This discussion is based on a reconnaissance field study conducted in the Spanish Sahara during the months of May, June, and July 1959. This survey was made from fixed-wing aircraft and helicopter, followed by an additional 8 weeks of ground-conducted field work from field-based camps, using Land Rover vehicles.--Auth.

3-4278. Rudd, Eric A. PETROLEUM DEVELOPMENTS IN SOUTHWEST PACIFIC REGION DURING 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 7, p. 1244-1248, map, 2 tables, July 1961.

This year may prove to have been one of the most important in the search for oil in Australia. An increased number of seismic crews were operating; much drilling was deferred until specific targets could be selected. Favorable conditions for exploration were: large concessions granted, stable conditions of tenure, generous subsidies for drilling and geophysical surveys, and help from the Commonwealth Bureau of Mineral Resources and state surveys.

In the Roma area of the Great Artesian Basin one well yielded 6.7 million cu. ft. of gas per day. Gas in near commercial quantities was found in the Sidney basin. Scattered stratigraphic tests found thick sections of possibly petroliferous sedimentary strata.--F. E. Kottlowski.

3-4279. Esfandiary, Mary S. COAL RESEARCH ORGANIZATIONS: THEIR ACTIVITIES AND PUBLICATIONS: U. S. Bur. Mines, Inf. Circ. 8008, 64 p., 1961.

This list of organizations that conduct research and development programs on coal has been compiled by the U. S. Bureau of Mines with the thought that such a directory may provide a useful guide to worldwide research efforts in the areas designated and may facilitate communication between organizations with similar interests. This list includes government, university, private, and commercial organizations. Many of these groups are conducting comparatively modest but often particularly interesting or specialized investigations. The areas of investigation have been defined in a broad manner - these include analysis and constitution, mining and geology, preparation, combustion, briquetting, high- and low-temperature carbonization, gasification, hydrogenation, Fischer-Tropsch, and health and safety. In some instances such information is not available, but the names of the organizations themselves often indicate immediate areas of interest. Special publications issued by and describing the work of each organization have been cited, when known; almost all of the organizations also publish results of their investigations in the technical press. Several foreign technical and trade publications that include such information and are not published directly by any of the organizations listed are cited in the pages following the list of organizations in each country.--From introd & summ.

3-4280. Averitt, Paul. COAL RESERVES OF THE UNITED STATES - A PROGRESS REPORT, JANUARY 1, 1960: U. S. Geol. Survey, Bull. 1136, 116 p., 10 figs., 6 tables, 1961, 195 refs.

The coal reserves of the United States remaining in the ground on Jan. 1, 1960, totaled 1,660,290 million tons. The total is based on recent, detailed, conservative estimates of reserves in 26 coal-bearing states, which include roughly 90% of the total estimated remaining reserves in the United States, and on older, generalized estimates for the few remaining states.

The estimated recoverable reserves as of Jan. 1, 1960, totaled 830,145 million tons, based on the assumption that half of the reserves in the ground will be lost in mining.

About 6% of the total is measured reserves in beds 28 in. or more thick and less than 1,000 ft. below the surface; and about 19% is indicated reserves, also in beds 28 in. or more thick, and less than 2,000 ft. below the surface. Measured reserves 1,000 to 2,000 ft. below the surface are insignificant. The remaining 75% is inferred reserves, reserves in thin beds, and reserves 2,000 to 3,000 ft. below the surface. The category of inferred reserves obviously includes some coal in thick beds for which detailed information is lacking.

Although based accurately on data now available, the distribution percentages are subject to considerable change as new work is completed, particularly in the transfer of reserves from the indicated and inferred categories to the measured category. The figures serve, however, to indicate the present state of knowledge of the nation's coal reserves, and they point to the need for additional geologic mapping and exploration.--Auth.

See also: Geomorphology 3-3977, 3-3978; Geophysics 3-4121.

3-4281. Yedlosky, Robert J. A PETROGRAPHIC STUDY OF SANDSTONES TO DETERMINE THEIR SUITABILITY FOR SUB-BASE AND BASE COURSE CONSTRUCTION: West Virginia Acad. Sci., Proc., v. 31/32, p. 167, 1959-1960.

The relation between petrographic features and physical tests was analyzed in the course of the study of West Virginia sandstones for use in road construction. Greater pore space is a factor in making high silica sandstones superior to argillaceous sandstone for these purposes.--M. Russell.

3-4282. Atchison, Thomas C., and Julius Roth. COMPARATIVE STUDIES OF EXPLOSIVES IN MARBLE: U.S. Bur. Mines, Rept. Inv. 5797, 20 p., 7 figs., 12 tables, 1961, 18 refs.

The experimental work described in this report is part of a continuing study by the U.S. Bureau of Mines of the fundamental physical processes involved in breaking rock with explosives. Six explosives were tested for their strain-producing abilities in a dolomitic marble. The explosives selected for testing had a tenfold variation in detonation pressure and a fivefold variation in characteristic impedance (product of loading density and rate of detonation). Strain pulses produced by the detonation of small charges of the explosives were recorded at distances of 5 to 130 ft.

Peak strain, ϵ, was found to decrease with distance, R, in accordance with an exponential propagation law previously determined for other rock types, namely

$$\epsilon = (K/R)e^{-\alpha R}$$

The absorption constant, α, did not vary significantly with the explosive and was of the same order of magnitude as that for other rock types. The different explosives produced a fivefold variation in the value of the intercept constant, K.

The intercept constant correlated with the explosive detonation pressure calculated by a simple approximation from the measured loading density and rate of detonation. However, correlation was better when the detonation pressure was replaced by the medium stress calculated from elastic wave theory and the ratio of characteristic impedance of the explosive to that of the rock. There was some indication that the impedance ratio of explosive to rock had an even greater effect upon the strain produced in the rock than would be expected from elastic theory.

The results of the tests provide a method for predicting the strain an explosive will produce in the Cockeysville marble from the loading density and detonation rate. Furthermore, the method can be used to predict the performance of a new explosive from the known performance of another explosive, either in the marble or in any rock type for which the characteristic impedance is known. The importance of the impedance ratio of explosive to rock shown by these tests helps to explain why the performance of low-strength explosives has exceeded expectations in many types of rock.--Auth. summ.

3-4283. Sandia Corporation, Sandia Laboratory, Albuquerque, New Mexico. PROJECT BUCKBOARD, INTERIM REPORT. By L.J. Vortman and others: U.S. Atomic Energy Comm., [Pub.] SC-4486(RR), TID-4500 (15th ed.), 77 p., 19 figs., 12 tables, 1960, 25 refs.

Thirteen high-explosive charges were fired at various depths in basalt as part of a larger series of high-explosive experiments for Project Plowshare. These experiments were performed by Sandia Corporation as part of the excavation program of Project Plowshare. Project Plowshare is directed toward the peaceful uses of nuclear explosives and is carried out under the technical direction of Lawrence Radiation Laboratory. Three 40,000-lb. spherical TNT charges were center detonated at 26, 43, and 59 ft. below the surface of a massive basalt flow. Two 1,000-pound charges were burst at each of depths 5, 10, 15, 20, and 25 ft. below the surface. Scatter in preliminary data prevented determination of departures from cube-root scaling. Variations of crater dimensions with burst depth were determined. Craters from cylindrical charges appear larger than those from spheres at deeper burst depths. The opposite is true for shallower burst depths. Maximum dimensions of craters from spheres are larger and are reached at shallower depths. At the same scaled depth of burst, maximum rock size increases with increases in energy yield. At the same energy yield maximum rock size increases with burst depth. Close air blast suppression is equal for charge burial in basalt and alluvium.--Auth.

3-4284. Coates, D.F., and A. Brown, STABILITY OF ROCK SLOPES AT MINES: Can. Mining & Metall. Bull,, v. 54, no. 591, p. 514-521, 9 figs., July 1961, 18 refs.

Slope problems arise on mining properties from cuts for roads and railroads and from open pits. When it is realized that 1,000,000 extra tons of waste may have to be mined as a result of an average slope being reduced by 1^{o} it is easy to appreciate that the slope problems connected with open pits are of far greater importance than the others.

The type of slope failure that can occur can be classified in different ways. The most useful classification would be one that separates the causes in such a way as to provide a basis for studies to deal with problems of prevention and control. Using this criterion the types of slope failures are classified into 4 groups.

Having classified the problems in this way an understanding can be gained of the various mechanisms involved in failure. It is then possible to examine in detail methods for preventing or controlling slope instability. Both analytical and practical aspects are presented with some description of procedures that can be followed. It is suggested that much can be done to handle slope problems rationally; however, it is also pointed out that the present state of knowledge leaves some large areas still to be dealt with by judgment.

The elements of slope analysis where our ignorance is most critical are described. The lines of research that should be conducted to strengthen this field are then established. The research work that is required seems not to be particularly formidable and within a reasonable time could lead to better control and more economic operation of open pits.--Auth.

3-4285. Agnew, Allen F. POSSIBLE UNDERGROUND STORAGE OF NATURAL GAS IN SOUTH DAKOTA: South Dakota, State Geol. Survey, Misc. Inv. no. 2, 15 p., 3 figs., table, 1961, 12 refs.

In May 1960, the natural-gas industry had 192 underground storage projects, with 25 new ones in

the testing or planning stages. South Dakota is not included among the 22 states where these projects are located.

Most of the storage is in depleted gas and/or oil pools, with the remainder in aquifers. Storing gas in depleted oil pools seems to have better economic potentialities than storing it in depleted gas pools, because of the possibility of secondary recovery of liquid hydrocarbons, thus recovering part if not all of the expense of the storage operation.

Major considerations for a depleted oil or gas pool to be used for underground storage of natural gas are listed by McNutt and Chappelle as follows: 1) geographic location of the depleted pool, 2) availability of the depleted pool, 3) number of wells in the depleted pool, 4) initial capacities of the wells, 5) cost of acquiring the necessary leases, and 6) cost of reworking the wells to prepare the pool for storage.

Underground storage of natural gas in aquifers is practiced in several states, including the neighboring Iowa. Potentialities of storage of gas under geologic conditions suitable for LPG (liquid petroleum gas) storage, such as in salt cavities and cavities mined in granite, should be investigated.--Auth. introd.

This report discusses gas production in South Dakota - Buffalo Field and Barker Dome Field; gas pipelines and population centers in South Dakota; stratigraphy and structural geology of South Dakota with reference to underground gas storage; possible areas for underground gas storage in South Dakota; and regulations affecting underground gas storage projects.

3-4286. Ogata, Akio, and Robert B. Banks. A SOLUTION OF THE DIFFERENTIAL EQUATION OF LONGITUDINAL DISPERSION IN POROUS MEDIA: U.S. Geol. Survey, Prof. Paper 411-A, 7 p., 3 figs., 1961, 9 refs.

Published papers indicate that most investigators use the coordinate transformation $(x-ut)$ in order to solve the equation for dispersion of a moving fluid in porous media. Further, the boundary conditions $C=0$ at $x=\infty$ and $C=C_0$ at $x=-\infty$ for $t>0$ are used, which results in a symmetrical concentration distribution. This paper presents a solution of the differential equation that avoids this transformation, thus giving rise to an asymmetrical concentration distribution. It is then shown that this solution approaches that given by symmetrical boundary conditions, provided the dispersion coefficient D is small and the region near the source is not considered.--Auth.

3-4287. Skibitzke, Herbert E. TEMPERATURE RISE WITHIN RADIOACTIVE LIQUID WASTES INJECTED INTO DEEP FORMATIONS: U.S. Geol. Survey, Prof. Paper 386-A, 8 p., 5 figs., table, 1961, 4 refs.

The data and method of analysis presented here provide for an approximate determination of expected temperature rises. They show that, in general, when large masses of liquid waste are injected into an aquifer through wells, heat conduction is not very significant, and as an approximation the temperature rise within the aquifer, since injection began, is equal to the total heat generated in a unit volume of aquifer divided by the product of the specific gravity of the aquifer and contained waste and its heat capacity. The generalizations outlined here should lead to an understanding of the relative importance of heat storage as compared to thermal conduction away from the region.--Auth.

3-4288. U.S. Beach Erosion Board. SAND MOVEMENT BY WIND ACTION (ON THE CHARACTERISTICS OF SAND TRAPS). By Kiyoshi Horikawa and Hsieh Wen Shen: Its: Tech. Memo. no. 119, 51, 6 p., 34 figs., 4 tables, 1960, 27 refs.

The movement of sand by wind action along the coast has long been a problem of importance to the coastal engineer engaged in the design and maintenance of shore protection works. Many research workers have studied this subject in the laboratory and/or in the field, but the mechanism of the sand movement as yet has not been solved completely. In particular, more field data are required to formulate a relationship between the rate of sand movement, the sediment characteristics, and the wind conditions. Prior to a program of field observation, one of the most important problems to investigate is the characteristics of sand traps and the selection of the most effective one for detaining a representative amount of sand transported by wind. Therefore in this report the main effort is devoted to the study of available sand traps and to development of a suitable type if needed.--Auth.

3-4289. U.S. Army, Corps of Engineers. RED RIVER AT GARLAND CITY, ARKANSAS: U.S. 87th Congress, 1st. sess., 1961, House Doc. no. 167, 36 p., fold. map, tables, Washington, D.C., U.S. Govt. Print. Off., 1961.

The meandering of Red River in the vicinity of Garland City, Arkansas, has produced a channel alignment which poses a continuing threat to the E. bank approaches and piers of the railway and highway bridges at this location. Should the present migration tendencies continue the bridges will be placed in an untenable position, and the embankment of the railroad, which also serves as the W. bank levee protecting Garland City, will be endangered.

The owners of the bridges, the St. Louis Southwestern Railway Lines and the Arkansas State Highway Dept., presented evidence of expenditures in excess of 1 million dollars on extensions and protective works to these bridges and requested construction of channel improvements and protection works to permanently realign the problem reach of Red River and to remove the danger to their bridges.

The plan for the solution of the bridge problems on Red River at Garland City consists of protective and realignment works commencing in the vicinity of the bridges and extending upstream for a distance of approximately 1 mi. Features of the work include construction of a pile revetment along the outer end of the existing pile dikes on the left bank above the railway bridge, construction of rock groins between the railway and highway bridges, the placement of riprap around the left bank railway bridge pier, excavation of the right bank at the railway bridge, construction of pile dikes on the right bank and the construction of a board revetment near an anticipated cutoff point.--From syllabus, p. 6.

3-4290. U.S. Engineer Dept., Garrison District. MADISON RIVER, MONTANA, REPORT ON FLOOD EMERGENCY, MADISON RIVER SLIDE: 2 v.: v. 1. main report; v. 2. appendices (technical reports), illus., maps, secs., diags., graphs, Omaha, Nebraska, U.S. Army Engineer District Omaha, 1960.

At the request of the governor of Montana, the U. S. Army Corps of Engineers was directed to investigate the flood problem and to take the steps necessary to remove the threat to life and property downstream from the slide in the Madison River canyon resulting from the Hebgen Lake earthquake of August 17, 1959. The activities of the Corps of Engineers in accomplishing this is reported. The principal danger was the prospect of a disastrous flood should Earthquake Lake overtop the slide and wash it out. The principal action taken to avoid this was the construction of a spillway over the slide and systematic reduction of its gradient until an acceptable factor of safety against failure had been provided. These emergency operations cost approximately $1,715,000.--M. Russell.

15. MISCELLANEOUS

3-4291. U. S. Dept. of the Interior. 1960 ANNUAL REPORT, SECRETARY OF THE INTERIOR...FOR THE FISCAL YEAR ENDED JUNE 30, 1960: 390 p., illus., diags., graphs, tables, Washington, D. C., 1960.

This report summarizes work of the following agencies: Bureau of Reclamation, Bonneville Power Administration; Southwestern Power Administration; Southeastern Power Administration; Office of Saline Water; Geological Survey; Bureau of Mines; Office of Oil and Gas; Office of Minerals Exploration; Office of Minerals Mobilization; Office of Geography; Bureau of Indian Affairs; Bureau of Land Management; National Park Service; Office of Territories; The Alaska Railroad; Fish and Wildlife Service; Bureau of Sport Fisheries and Wildlife; Bureau of Commercial Fisheries.--A. C. Sangree.

3-4292. Blackadar, Robert G. FIELD METHODS AND LOGISTICS: ARCTIC CANADA (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1095-1101, 2 tables, Toronto, University of Toronto Press, 1961)

The Geological Survey of Canada has pioneered in the use of light aircraft for reconnaissance surveys in the N. and this approach has resulted in the mapping of more than 500,000 sq. mi. during the past 8 years. The organization and field operations of certain of these projects are described. Attention is also given to some of the older and more conventional techniques, such as coastal reconnaissance, which are of value in certain parts of the N.--Auth.

3-4293. Harwood, T.A. MODERN METHODS OF EXPLORATION IN THE CANADIAN ARCTIC ISLANDS, WITH SPECIAL RESPECT TO LOGISTIC PROBLEMS (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1102-1111, Toronto, University of Toronto Press, 1961) 23 refs.

The author examines, from 1946 onwards, the development of present methods of exploration and logistics in the Arctic Islands and northern Canada: the types of ship involved, ice conditions generally encountered, and methods of cargo handling. Some discussion is directed to aircraft logistics and types of planes so far used in the Arctic Islands, and this is related to the bearing strength of ice. Consideration is given to the effect of climate on logistics, and reference is made to some specialized foods produced to reduce logistic loads. The paper as a whole attempts to relate climate and weather, sea ice, navigation, permafrost conditions, and communications to logistics.--Auth.

3-4294. Jacobsen, George. JACOBSEN-McGILL UNIVERSITY EXPEDITION AXEL HEIBERG ISLAND 1959-61 (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1188-1192, 2 figs., Toronto, University of Toronto Press, 1961)

The Jacobsen-McGill Arctic Research Expedition to Axel Heiberg Island is the joint effort of McGill University and George Jacobsen. Its main objective is to gain knowledge of the Pleistocene and Recent physiographic evolution of central Axel Heiberg Island, including the geology and permafrost of the area.

The expedition will run for 3 years and will include surveying, geology, glaciology, hydroglaciology, glacial meteorology, seismic and gravity surveys, geomorphology, permafrost, and botany. At its completion the base camp will be used as a permanent arctic research station for McGill University.--Auth.

3-4295. Winsnes, Thore S. ACTIVITIES OF NORSK POLARINSTITUTT (NORWEGIAN POLAR INSTITUTE) IN SVALBARD (In: Raasch, Gilbert O., ed. Geology of the Arctic...: v. 2, p. 1167-1184, 9 figs., Toronto, University of Toronto Press, 1961) 240 refs.

Since 1906 Norwegian expeditions have gone to Svalbard every summer (except during World War II), carrying out hydrographic, topographic, and geologic surveys. After the establishment of Norwegian sovereignty in Svalbard through the international treaty of 1925, the Norges Svalbard-og Ishavs-undersøkelser (Norwegian Exploration in Svalbard and the Polar Seas) was founded as a continuation of the state-supported Norwegian Spitsbergen Expedition. The results are published in a series of Skrifter (papers) and Meddelelser (shorter notes). In 1948, the Norsk Polarinstitutt was founded as an expansion of the former institution; it has now a staff of 21.

In the course of the years the western waters of Svalbard have been charted and 11 charts issued. During the summers of 1936 and 1938, the whole of Svalbard was photographed from the air, and the new color maps at a scale of 1:100,000 are based on these photographs. Eight of the standard maps have been published. The geological exploration of Svalbard has made possible collections of fossils and rock specimens, resulting in important paleontological and stratigraphic contributions. Stress has been laid on an investigation of the Tertiary coal, which is being mined in several places. The areas surveyed geologically will be included in maps based on the standard 1:100,000 topographic maps. Special glaciological investigations are also being undertaken. In addition, Norsk Polarinstitutt acts as an adviser to foreign expeditions, furnishing necessary maps and information.

Norsk Polarinstitutt will continue to operate along these well-established lines. Charting of the northern areas of the Norwegian Sea will be started, and a pilot sailing of Svalbard waters will be completed. Cooperation with other institutions in similar fields of activity will continue.--Auth.

3-4296. Belcher, A.T. THE ARCTIC INSTITUTE OF NORTH AMERICA (In: Raasch, Gilbert O., ed.

Geology of the Arctic...: v. 2, p. 1193-1196, Toronto, University of Toronto Press, 1961)

The Arctic Institute of North America is a non-profit research organization incorporated in Canada and the U.S.A. with offices in Montreal and Washington. It has pioneered basic arctic studies for North America and has financed over 300 field studies in all subjects since 1946, and also provides such basic research tools as the Arctic Bibliography which cross-refers 50,000 English abstracts from papers in over 20 languages and every subject. In recent years it has also undertaken contract research on a cost and overhead basis, so that it played a significant role in both polar regions during the IGY.

Such preparations as the Arctic Bibliography, the Glacial Map of Canada, and the basis revision for Canada's new "Arctic pilot," are typical of the work to which the Institute is well suited, and there have also been compilations of subject and site bibliographies.

The Library of the Institute of Montreal stands well in the top 4 of the world's Arctic libraries, is the largest single collection in Canada, and serves as a mainstay of the Carnegie-McGill Arctic scholarships which are unique in the western world.

In 1960 the Institute financed 19 private field parties, undertook research on the Ellesmere ice shelf for the U.S. Air Force, and installed research stations on Devon Island, Northwest Territories, Canada. It hopes to raise funds in order to provide arctic data for the new continuing project for charting North Atlantic marine biology.--Auth.

3-4297. THE DEVELOPMENT OF SCIENTIFIC RELATIONS BETWEEN GEOLOGISTS OF THE ACADEMY OF SCIENCES OF THE CHINESE PEOPLE'S REPUBLIC AND THE U.S.S.R. ACADEMY OF SCIENCES: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 10, p. 1-2, pub. 1961.

Relations between geologists of the U.S.S.R. and the Chinese People's Republic originated in pre-Revolutionary times but have been continuously expanded since the establishment of the C.P.R. Important geologic problems investigated commonly by both countries at all-union conferences include magmatism and ore deposits. In connection with the compilation of the tectonic map of Eurasia exchange visits were made notably to the Russian platform, the Donbas (Donets coal field), and the Caucasus. Petrologic and metallogenic studies of ultrabasic intrusions were made in the Urals and elsewhere. Other subjects of common study are the laws of formation of Pacific belt structure and related magmatism and metallogeny; the construction of a chronologically absolute time scale for Eurasia based on data for igneous rocks; the determination of laws of magmatic development in time and space, together with geophysical investigations for increased understanding of geological processes taking place under plutonic conditions and consequently contributing more fully to knowledge of the laws governing the composition and development of the earth's crust.--J. W. Skehan.

3-4298. Bemmelen, R. W. van. THE SCIENTIFIC CHARACTER OF GEOLOGY: Jour. Geology, v. 69, no. 4, p. 453-463, 2 figs., table, July 1961, 31 refs.

In this paper the scientific character of geology is discussed by analyzing the very nature of the interrogation of the earth by the geologist.

Geology differs from physics, chemistry, and biology in that the possibilities for experiment are limited. As geology is essentially an historical science the working method of the geologist resembles that of the historian. This makes the personality of the geologist of essential importance in the way he analyze the past. This subjective element in geologic studies accounts for 2 characteristic types that can be distinguished among geologists: one considering geology as a creative art, the other regarding geology as an exact science.

Next, the nature of the earth, object of geological studies, is considered. The increasing number of factors playing a role in the various complexes of natural phenomena are the origin of new, so-called emergent, laws and characteristics. Based on this principle of emergence, a hierarchy of sciences can be distinguished: physics - chemistry - geology - biology - psychology.

The geologist applies a certain number of general views and concepts which are the rules for his scientific practice. Such premises, however, are less fixed than the natural laws postulated by the basic sciences of physics and chemistry. The geologist is therefore forced to test the validity of the greatest possible number of presuppositions (method of multiple working hypotheses).

The principle of "uniformitarianism" and the method of "comparative ontology" are examples of geologic rules. The relations between geology and its sister sciences are illustrated. Finally, the tremendous possibilities of future expansion of geology are indicated.--Auth.

3-4299. Parker, Ben H. ATTRIBUTES OF THE GEOLOGIC PROFESSION: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 7, p. 1005-1010, July 1961, ref.

The majority of petroleum geologists are instructing, advising, or serving others through a knowledge of geologic science. Five attributes of the profession are: 1) the body of scientific theory that dates back to 300 B.C., 2) the ethical code, 3) the professional authority whereby employers or clients place full faith and responsibility in the judgment and skill of the geologist employed, 4) the community sanction of professional geologic practice, and 5) scientific and economic cultural contributions of benefit to society at large.

Responsibility walks hand in hand with capacity and power. We have the capacity and latent power. We must elect to accept the obligation.--F. E. Kottlowski.

3-4300. Furnish, W. M. ROLE OF A SPECIALIST: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 7, p. 1011-1013, July 1961.

The broad original aims of the Society of Economic Paleontologists and Mineralogists can be regarded as sponsoring expertness or specialization in one phase of petroleum geology. At the earliest stage, the society was chiefly of micropaleontologists. The use of electric logs stifled some applications of practical paleontology. Mineralogy-petrology, as a field paralleling that of micropaleontology, failed to materialize.

Of concern today is the origin of specialists and future sources of these individuals. A stated principle for university education is that nothing should be taught which can be learned better on the job in a few months. This rule has not been the controlling thought in geologic curricula over a period of years. --F. E. Kottlowski.

AUTHOR INDEX

	Abstract
Agnew, Allen F.	3-4285
Ahmad, Naseeruddin	3-3970
Annotated Bibliography of Economic Geology	3-4233
Arnold, K.C.	3-3964
Atchison, Thomas C.	3-4282
Atlasov, I.P.	3-4011
Austin, Charles R.	3-4205
Austin, W.G.C.	3-4183
Averitt, Paul	3-4280
Ayanov, V.M.	3-4189
Baadsgaard, H.	3-4052
Banks, Robert B.	3-4286
Bassett, H. Gordon	3-4026
Bataliev, A.D.	3-4187
Bates, Charles C.	3-4117
Bayes, Frances S.	3-4267
Beals, Carlyle S.	3-4000
Beals, H.O.	3-4076
Bear, Jacob	3-4200
Bedinger, M.S.	3-4202
Belcher, A.T.	3-4296
Bemmelen, R.W. van	3-4298
Benz, Leo C.	3-4221
Berg, Robert R.	3-3955
Berge, Charles W.	3-4190
Berthelsen, Asger	3-4050
Beschel, R.E.	3-4055
Bidgood, D.E.T.	3-4096
Bissell, Harold J.	3-4034
Blackadar, Robert G.	3-4015, 3-4292
Blake, Weston, Jr.	3-4054
Bleakley, W.B.	3-4261
Bogokina, F.E.	3-4165
Broch, Olaf Anton	3-4150
Brodskaya, S.Yu.	3-4095
Bromfield, C.S.	3-3946
Brown, A.	3-4284
Brown, Charles W.	3-4044
Bryant, Donald L.	3-4037
Buffington, Edwin C.	3-4192
Bulashevich, Yu.P.	3-4125
Bulin, N.K.	3-4111
Buné, V.I.	3-4109
Burr, S.V.	3-4103
Busch, Daniel A.	3-4264
Butler, H.	3-4025, 3-4033
Caldwell, Dabney W.	3-3956
Caliomon, J.H.	3-4042
Campau, Donald E.	3-4014
Carey, S. Warren	3-3970
Carman, E.P.	3-4267
Carnegie Institution of Washington	3-4087
Carrier, John B.	3-4277
Carsola, Alfred J.	3-3989
Cederstrom, D. John	3-4209
Chinnery, M.A.	3-4079
Chizhikov, P.N.	3-3986
Clayton, Robert N.	3-4144
Coates, D.F.	3-4284
Coats, Robert R.	3-3954
Cobban, William A.	3-4061
Colby, Bruce Ronald	3-4201
Colley, G.C.	3-4080
Colton, Roger B.	3-3945
Conant, Louis C.	3-4029
Cook, A.C.	3-4141
Cook, Frank A.	3-3979
Copeland, R.J.	3-4083
Corbett, J.O.	3-4236
Cowie, J.W.	3-4021
Craig, Bruce G.	3-3972
Craig, D.B.	3-4146
Cram, Ira H.	3-4275
Crittenden, Max D., Jr.	3-4247
Cromie, William J.	3-4129
Dale, Vernon B.	3-4242
Daniels, Farrington	3-4132
Davies, William E.	3-3969, 3-3977
Denning, Reynolds M.	3-4152
Desborough, George A.	3-4030
Devitsyn, V.M.	3-4092
Devlin, Frank J.	3-4013
Disbrow, Alan E.	3-3947
Donaldson, Alan C.	3-4195
Donn, William L.	3-3962
Donovan, D.T.	3-4043
Douloff, Artel A.	3-4097
Dunbar, Carl O.	3-4064
Dunning, H.N.	3-4142
Duvall, Wilbur I.	3-4106
Dyer, C.F.	3-4225
Eakins, P.R.	3-4231
Eardley, A.J.	3-4001
Edie, Ralph W.	3-4268
Egerton, W.G.	3-4259
Eliseev, V.I.	3-4048
Epstein, Samuel	3-4144
Erd, Richard C.	3-4159
Eremeev, V.P.	3-4184
Ermakov, N.P.	3-4145
Esfandiary, Mary S.	3-4279
Ethington, R.L.	3-4070
Ewing, Clair E.	3-4077
Ewing, Maurice	3-3962, 3-4002
Farnham, Lloyd L.	3-4246
Feofilaktov, V.D.	3-4112
Fleming, H.W.	3-4235
Foose, Richard M.	3-4009
Fournier, Robert O.	3-4135
Foxworthy, Bruce L.	3-3948
Fraser, D.C.	3-4241
Fraser, James Allan	3-4015
Frischknecht, Frank C.	3-4105
Fristrup, Børge	3-3966
Frueh, Alfred J., Jr.	3-4157
Fuller, J.G.C.M.	3-4023
Furnish, W.M.	3-4062, 3-4300
Fyles, John Gladstone	3-3972
Gaiski, V.N.	3-4110
Gaither, L.Q.	3-4259
Gardner, Frank J.	3-4270
Garland, G.D.	3-4082
Geyer, Richard A.	3-4260
Geyl, W.F.	3-3984
Giudice, Daniele del	3-3959, 3-3960
Glenister, Brian F.	3-4062
Godlevsky, M.N.	3-4187
Goodwin, A.M.	3-4244
Gregg, Dean O.	3-4210
Gregory, A.F.	3-4089
Grigorev, D.P.	3-4155
Grolier, Maurice J.	3-3948
Gubelin, Edward J.	3-4176
Guyod, Hubert	3-4262
Halberg, Henry N.	3-4223
Hall, E.	3-4207
Haller, John	3-4003, 3-4004
Harksen, John C.	3-4047
Harland, W.B.	3-4010, 3-4096
Harris, T.M.	3-4075
Harrison, Richard Edes	3-3950
Hart, S.R.	3-4051
Harwood, T.A.	3-4293
Hattersley-Smith, G.	3-3968
Hawes, Lorin	3-4151
Heezen, Bruce C.	3-4002
Heier, K.S.	3-4138
Hills, John M.	3-4036
Holmes, G. William	3-3974
Horikawa, Kiyoshi	3-4288
Hubbell, David W.	3-4193
Hunkins, Kenneth L.	3-4120, 3-4198
Hurlbut, Cornelius S., Jr.	3-4170

	Abstract
Ingall, L.N.	3-4083
Ito, Jun	3-4168
Jacobsen, George	3-4294
Jaffe, Howard W.	3-4167
Janssen, Raymond E.	3-3976
Jarvik, Erik	3-4066
Jeletzky, J.A.	3-4008
Jenkins, Edward D.	3-4211
Jodry, Richard L.	3-4014
Johnson, M.R.W.	3-4191
Jorgensen, Donald G.	3-4226
Kalashnikov, A.G.	3-4093
Kalyuzhnyy, V.A.	3-4145
Kansas Geological Society	3-3957
Katz, H.R.	3-4017
Kazinsky, V.A.	3-4081
Keefer, William R.	3-4046
Keller, George V.	3-4105
Kelly, William C.	3-3980
Kennedy, Richard R.	3-3958
Kent, P.E.	3-3999
Kerr, Paul F.	3-4154
Khomentovsky, V.V.	3-4018
King, Elbert A., Jr.	3-4169
Kittrick, J.A.	3-4175
Kjellesvig-Waering, Erik N.	3-4063
Knudsen, William C.	3-4119
Koch, Lauge	3-3952
Kohout, F.A.	3-4206
Kolmakov, M.V.	3-4099, 3-4100
Konishi, Kenji	3-4074
Konta, J.	3-4172
Kopaev, V.V.	3-4094
Kopp, Otto C.	3-4164
Kostov, Ivan	3-4173
Kranck, Ernst H.	3-3998
Kraskovsky, S.A.	3-4127
Kretz, Ralph	3-4133
Krinsley, D.B.	3-3971
Krutak, Paul R.	3-4072
Laevastu, Taivo	3-4136
Laganá, Tito	3-4178, 3-4243
Lang, Solomon M.	3-4203
Langston, Wann, Jr.	3-4058
Lapina, M.I.	3-4088
Larochelle, A.	3-4147
Layat, C.	3-4123
Leary, J.K.	3-4174
Legget, Robert F.	3-3978
Lenz, Alfred C.	3-4059
Lerbekmo, John F.	3-4196
Lewis, Charles R.	3-3974
Loranger, D.M.	3-4069
Lum, Daniel	3-4086
McCallum, Henry D.	3-3995
McCaslin, John C.	3-4272
MacChesney, J.B.	3-4134
McClymonds, Neal E.	3-4037
MacDonald, Gordon J.F.	3-4126
MacDonald, William D.	3-4028
McDougall, Ian	3-4182
McGhee, Ed	3-4257
McGill, Peter C.	3-4069
McLaughlin, Thad G.	3-4212
McNair, A.H.	3-4007
Maher, John C.	3-4019
Mann, Virgil I.	3-4085
Markov, F.G.	3-4020
Martin, L. John	3-4005
Martynova, T.A.	3-4094
Mason, Ronald G.	3-4090, 3-4091
Mather, A.L.	3-4234
Maughan, Edwin K.	3-3944
May, David V.	3-3983
Maync, Wolf	3-4035
Meador, Jimmie G.	3-4122

	Abstract
Melhorn, Wilton N.	3-4076
Mellis, Otto	3-4136
Melton, Mark A.	3-3975
Menke, C.G.	3-4214
Mertie, John B., Jr.	3-4149
Meyer, Gerald	3-4230
Meyrowitz, Robert	3-4148
Miller, Maynard M.	3-3973
Miller, Robert D.	3-4053
Milton, Charles	3-4171
Milton, Daniel J.	3-4168
Minakami, Takeshi	3-4179, 3-4180
Molloy, Martin W.	3-4154
Monakhov, F.I.	3-4113
Moore, Raymond C.	3-4071
Morey, George W.	3-4135
Moulder, Edward A.	3-4213
Mráz, L.	3-4172
Muan, Arnulf	3-4134
National Academy of Sciences-National Research Council	3-3987
Nelson, R. William	3-4199
Nevada Water Conference, 14th, Carson City, 1960	3-4218
New Mexico, Institute of Mining and Technology	3-4252
Nichols, Donald R.	3-3991
Nile, Stephen W.	3-4107
Nobles, Laurence H.	3-3967
Norris, D.K.	3-3997
Nosov, G.I.	3-4165
Novikova, A.S.	3-4012
Off, Theodore	3-4102
Ogata, Akio	3-4286
Ohio, Division of Water	3-4222
Pabst, Adolf	3-4153
Panassenko, G.D.	3-4108
Park, R.	3-4142
Parker, Ben H.	3-4299
Parodiz, J.J.	3-4060
Paterson, Norman R.	3-4078
Patterson, J.R.	3-4022
Pavlova, T.G.	3-4188
Pelletier, Bernard R.	3-4041
Pemberton, Roger H.	3-4130
Petersen, William A.	3-4273
Pierce, Clyde I.	3-4265
Piotrovsky, G.L.	3-4158
Plouff, Donald	3-4128
Podyapolsky, G.S.	3-4116
Potter, Paul Edwin	3-4197
Pranglin, John A.	3-4262
Pryor, Wayne A.	3-4197
Raasch, Gilbert O.	3-3951, 3-4065
Rabkin, M.I.	3-4016
Radkevich, B.A.	3-4238
Radkevich, E.A.	3-4237
Raff, Arthur D.	3-4090, 3-4091
Ramsahoye, L.E.	3-4203
Ravich, M.G.	3-4016
Reece, Alan	3-4234
Reed, J.E.	3-4202
Remson, Irwin	3-4204
Rex, Robert W.	3-3981
Richardson, Everett E.	3-3949
Riley, Christopher	3-4240
Riznichenko, Yu. V.	3-4115
Rocky Mountain Association of Geologists	3-3955
Rodermund, C.G.	3-4263
Rodis, Harry G.	3-4216, 3-4217
Roethlisberger, Hans	3-4121
Rogers, Wiley S.	3-4024
Rold, John W.	3-3955
Rose, Harry J., Jr.	3-4143
Roth, Julius	3-4282
Rowe, Robert B.	3-4249

	Abstract
Rudd, Eric A.	3-4278
Ruhe, Robert V.	3-3985
Russell, W.A.C.	3-3999
Sachs, V.N.	3-4038
Sainsbury, Cleo L.	3-3953, 3-3988
Sandberg, Charles A.	3-4027
Sanderson, L.	3-4248
Sandia Corporation, Sandia Laboratory, Albuquerque, New Mexico	3-4283
Sandidge, John R.	3-4274
Saul, LouElla Rankin	3-4056
Saul, Richard B.	3-4056
Savinsky, I.D.	3-4124
Schaub, Yu. B.	3-4101
Schmeck, Harold M., Jr.	3-4131
Schneider, Robert	3-4217
Scholl, David W.	3-3988
Schwarzacher, Walter	3-4198
Sclar, Charles B.	3-4161
Scott, Glenn R.	3-4053
Segeler, Curt G.	3-4166
Senko-Bulatny, I.N.	3-4125
Shen, Hsieh Wen	3-4288
Shotts, Reynold Q.	3-4031
Sidorenko, E.F.	3-4162
Silvey, William D.	3-4140
Simms, Frederick E., Jr.	3-4032
Skibitzke, Herbert E.	3-4287
Smith, David D.	3-3965
Smith, William O.	3-4266
Snyder, George L.	3-3943
Sobolev, N.D.	3-4185
Sokolov, V.N.	3-4011
Solórzano Marín, Roberto	3-4253
Sproule, J.C.	3-4269
Stegena, L.	3-4258
Stensiö, Erik	3-4067
Stern, Thomas W.	3-4143
Stevens, Edmund	3-4276
Stewart, Harris B., Jr.	3-3990
Stinson, Melvin C.	3-4156
Stone, M.	3-4183
Stout, Wilber	3-3992
Straaten, L.M.J.U. van	3-4194
Strelkov, S.A.	3-4038
Strunz, H.	3-4160
Stubbins, John B.	3-4245
Sukachev, V.N.	3-3963
Sullivan, Walter	3-4177
Swain, Frederick M.	3-4073
Swanson, Vernon E.	3-4029
Tanner, William F.	3-3961
Tasch, Paul	3-4057
Texas, Agricultural and Mechanical College System, Water Research and Information Center	3-4228
Thalmann, Hans E.	3-4068
Thorsteinsson, R.	3-4006
Tkachenko, B.V.	3-4020
Tolstoy, Ivan	3-4114
Tomashevskaya, I.S.	3-3994
Tomkeieff, S.I.	3-4186
Tomson, I.M.	3-4238
Toporets, S.A.	3-4104
Tozer, E.T.	3-4006, 3-4039
Trümpy, Rudolf	3-4040
Tupper, William M.	3-4051
U.S. Air Force, Cambridge Research Center, Geophysics Research Directorate	3-4077
U.S. Army, Corps of Engineers	3-4289
U.S. Beach Erosion Board	3-4288
U.S. Congress, Senate, Select Committee on National Water Resources	3-4208, 3-4215
U.S. Dept. of the Interior	3-4291
U.S. Engineer Dept., Garrison District	3-4290
U.S. Geological Survey	3-4210
Vacquier, Victor	3-3996
Van Melle, F.A.	3-4118
Van Sant, Joel N.	3-4250
Vinogradov, A.P.	3-4137
Vladimirov, N.P.	3-4100
Walker, Ian R.	3-4224, 3-4227
Weber, J.R.	3-4084
Wenk, Eduard	3-4045
Westley, Harold	3-4148
Wilmoth, Benton M., Jr.	3-4229
Wilshire, H.G.	3-4181
Wilson, A.	3-4174
Winsnes, Thore S.	3-4295
Woods, J.P.	3-4254
Woodward, Herbert P.	3-3982
Wray, John L.	3-4074
Wrucke, Chester T.	3-3946, 3-4049
Yakushevskaya, I.V.	3-4139
Yang, Julie Chi-Sun	3-4163
Yedlosky, Robert J.	3-4281
Yehle, Lynn A.	3-3991
Yungul, S.H.	3-4098
Zablocki, Frank S.	3-4085
Zakharov, E.E.	3-4232
Zink, Edman R.	3-4255
Zones, C.P.	3-4219, 3-4220
Zoppis Bracci, Luigi	3-3960, 3-4239, 3-4251
Zumberge, James H.	3-3980